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A N  
E S S A Y  
CONCERNING THE  
*EFFECTS* of *AIR*  
O N  
HUMAN BODIES.

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A N  
E S S A Y  
CONCERNING THE  
E F F E C T S  
O F  
A I R  
O N  
H U M A N B O D I E S.

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By *JOHN ARBUTHNOT*, M. D.  
Fellow of the *Royal Colleges of Physicians of London*  
and *Edinburgh*, and of the *Royal Society*.

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L O N D O N:

Printed for J. and R. T O N S O N and  
S. D R A P E R in the *Strand*.

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M D C C L I.



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T H E  
P R E F A C E.



IN the Preface to my *ESSAY on the Nature and Choice of Aliment*, I promised to treat the other *Non-naturals*, Air, Rest, and Motion, after the same manner. I now choose to perform my Task imperfectly, rather than break my Word.

*Air* is the next in Order, which, reflecting what a Share it has in all Animal Operations, I am of Opinion, has not been as yet sufficiently

ficiently consider'd as to the Physiology of its Effects : Philosophers, Mathematicians, Chymists, the Professors of Agriculture and Gardening, have attended to the Effects of Air on the Subjects of their several Arts, more than the Physicians. The Reason of which Neglect may be, that Air is one of those *Ingesta*, or things taken inwardly, which neither can be forborn nor measur'd in Doses: But the Use of Air being unavoidable, is no Reason against inquiring into its Effects; besides, it is incumbent upon the Professors of our Art to know and assign, as far as they can, the true Causes of the Changes which happen in Human Bodies; and there are many more useless Inquiries than this, about the Effects of Air, which are daily the Subject of Human Curiosity. But tho' Abstinence  
from



from Air is not, the Sort of Air which they use, is in the Power of a great many People: And as the Choice of Air is a Subject about which a Physician's Advice is often demanded, its Nature and different Qualities is a proper one of his Studies; and it seems preposterous that there should be so many minute Inquiries about the Qualities of every Drug which we take but seldom, and none into the Effects of a Substance that we take inwardly every Moment.

The most famous Physicians have observ'd, with great Assiduity, the Effects of Air in the Oeconomy of Diseases, and none perhaps with so much Accuracy as the first Founder of our Art, the great *Hippocrates*. Air is the τὸ αἶον in Diseases, which he takes notice of. Air is what he means by the Powers of the Universe,

which he says Human Nature cannot overcome ; and he lays it down as a Maxim, \* ‘ that whoever intends to be Master of the Art of Phyſick, muſt obſerve the Conſtitution of the Year ; that the Powers and Influence of the Seasons (what are ſeldom uniform) produce great Changes in Human Bodies.’ Dr. *Sydenham*, endowed with the Genius of *Hippocrates*, has left us *Epidemicks* wrote upon the Model of thoſe of *Hippocrates*, containing a Hiſtory of acute Diſeaſes as depending upon the Conſtitution of the Season. Some eminent Phyſicians in *Italy* and *Germany* have imitated Dr. *Sydenham* ; and a Society of learned and ingenious Gentlemen of the Profeſſion at *Edinburgh* are now purſuing the ſame Scheme. I was ſo

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\* De Aere, Locis & Aquis.

uninquisitive as not to have seen, till my *Essay* was almost finish'd, an excellent Performance in the same way, the Nosological Commentary of Dr. *Clifton Winteringham*, comprehending the History of Epidemical Diseases, with a Journal of the Weather in the City of *York* from 1715 to 1725. My Misfortune in not seeing it sooner was lessen'd in some Degree by finding some of my Reasonings confirm'd by Observations.

In an Oration I made some Years ago before the College of Physicians, I recommended the keeping a Journal of the Weather and reigning Diseases, as a Thing which might be of singular Use, especially to Posterity: I have had the Pleasure to see this executed by the learned and industrious Professor *Mussenberg*, with such an elegant Contrivance, and so nice an Accuracy

curacy in his Meteorological Tables, that if the Design is pursued for many Years, it may perhaps reduce the Physiology of the Air to a Science.

As for the following Essay I propose it only as a Model of something more perfect to be done afterwards by an abler Pen upon the same Subject: It contains at least a methodical Disposition of the several Heads of Inquiry in reasoning upon this Part of the Physiology of the Air. In compiling it, I purposely avoided turning over a great many Books, or considering any thing indeed but Matter of Fact, upon which I founded my Reasonings; and I ought to beg Pardon for the Presumption of the Attempt, rather than say any thing for the Merit of the Work, in Excuse for the Imperfections, Inaccuracies, and perhaps

haps Mistakes that are in it. I have the following Particulars to plead ; that a great Part of it was wrote with frequent Interruptions, in small Portions of Time, and some Things from my Memory ; that Weariness in thinking about the same Subject, incident to me perhaps with others of Mankind, made me abandon several Particulars too soon ; that I did not know any Friend who had study'd the Subject enough to give me Advice ; and therefore I now set it before every body who is capable of putting me right, and I shall be far from thinking that he that corrects, refutes me. If there be any Inaccuracies in the Numbers, they will not invalidate the Reasoning. I think I may venture so far as to affirm, that he who reads the whole over with due Attention will find it not quite an usefess Speculation.

T H E





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A N

# ESSAY


Concerning the

*Effects of AIR on HUMAN BODIES.*

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## CHAP. I.

*Of the Contents of the Air.*

I.  AIR is that thin Fluid which furrounds the Earth in which we move and breathe. Air is not visible. What we see in the Stream of Light let in by a small Aperture into a Room, is not Air, but Dust, and other Bodies floating in the Air. Air is sensible to the Touch by its Motion, and by its Resistance to Bodies moved in it.

B

II. Air

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II. Air is the principal Instrument of Nature in all its Operations on and within the Surface of the Earth, except Magnetism and Gravity. No Vegetable nor Animal, terrestrial nor aquatic, can be produc'd, live, or grow, without Air. Eggs cannot be hatch'd, nor Vegetables grow in a Void. Water, purg'd of Air, will not make Plants vegetate, at least very slowly, and that only by some Quantity of Air that is left in the Water. Air is the chief Instrument in the Oeconomy of Fossils; all Operations, natural and artificial, on Fossils, depend upon Air; for without the Assistance of Air, Fire and Heat cease. In a word, Air is the principal Instrument in the Generation, Accretion, Resolution, and Corruption of all terrestrial Bodies; for it enters into the Composition of all Fluids and Solids, all of which generate or produce Air in great Quantities: Oak has generated  $\frac{1}{3}$  of its Weight in Air, Pease as much, *Indian Wheat*  $\frac{1}{4}$ ; Substances oily and tenacious either do not produce it so much, or part not with it so easily; as Honey, which does not yield  $\frac{1}{6}$ ; or Bees-wax, which yields  $\frac{1}{16}$ ; Minerals yield a great Quantity of Air, *New-Castle Coal*  $\frac{1}{2}$  of its Weight, *Antimony* about 28 times its Bulk, acid Spirits in Solution

## *Effects of Air on Human Bodies.*

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tion of Metals generate great Quantities. Those who desire to know more of this Subject, may consult the *Vegetable Staticks* of the ingenious and industrious Mr. *Hales*. Animal Substances are replete with Air more than any other. Blood will generate 33 times its bulk of Air; and solid animal Substances yield more Air than the Fluids; a human *Calculus*, or Stone, yields more than 645 times its bulk of Air; but of this more afterwards. At present we will briefly enumerate the most considerable Contents of this wonderful Fluid. The Air near the Surface of the Earth, in which all Animals live and breathe, contains the Steams, Effluvia, and all the Abrasions of Bodies on the Surface of the Earth, when they are so small and light as to float in it; from whence it is evident, that the Contents of it must be different in different Places of the Surface of the Earth.

III. I shall not enter into a Dispute about the Nature of Fire; but if it be an Element that pervades all the Space of the Universe, as the learned *Boerhaave* imagines, Air must contain its Proportion of this Element.

IV. Air contains Water which is daily exhal'd, and daily falls from the Air; a

Surface of Water, expos'd to the Air, evaporates an Inch in 13 Days; a Surface of Earth, with a Summer Heat, evaporates about an Inch in 40 Days; which Water, when the Air is overcharg'd with it, is return'd again, and falls upon the Surface of the Earth in Rain and Dew, which, by Observation in this Part of the terraqueous Globe, at a Medium, in a Year makes about 22 Inches of Rain, and  $2\frac{1}{2}$  Inches of Dew; the Dew falls chiefly when the Sun is down, and near double the Quantity in a Winter of what falls in a Summer's Night. Thus it is plain, that there is a great Quantity of Water constantly floating in the Air; and many other Experiments demonstrate the same.

V. Fix'd alkaline dry Salts attract, and are dissolv'd by the watery Particles of the Air, so as to increase in Weight from 34 to 57 in three Days; and this Effect may be carried on so as to quadruple the Weight, 1 Ounce of Salt of *Tartar* making 4 Ounces of Oil of *Tartar*, *per deliquium*, only by Attraction of Water from the Air; reckoning a cubical Inch of Air to weigh  $\frac{2}{7}$  of a Grain, the additional Weight of 3 Ounces would make 5040 cubical Inches of

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of Air, near 3 cubical Feet. There are many Consequences, which seem Paradoxical, to be drawn from this Experiment; for Example, that the most ponderous of Liquors, except *Mercury*, should be made of Salt and Air; that of Salt and Water, drawn from the Air, there should be made a Liquor of greater specifick Gravity than the Mixture of the Ingredients; for the Oil of *Tartar per deliquium* is in weight to Water as 7 to 5; and one Part of Salt of *Tartar*, with three Parts of Water, will make a Liquor which is to Water as 6 to 5. What naturally follows from the Experiment is, that either there is a great Quantity of Water in the Air, or that the Water attracted by the Salt is drawn from a great Quantity of Air.

VI. The Air is, perhaps, most charg'd with Water when it is clear; for when the Air is heaviest, the Vapours ascend the highest; but when they are highest, they are more eluted, and better mix'd with the Particles of Air; they ascend at least as high as the Tops of the highest Mountains, by the Clouds and Snow that are seen there, and where the Vapours often form Springs; when the watery Vapours turn a little heavier than the Air, they gather into Smoke or

B 3

Clouds,

Clouds, which, when their Weight cannot be any more sustain'd by the Air, fall down in a thin Rain; and these Particles, by falling from greater Heights, unite, and form great Drops of Rain; and when frozen by the extreme Coldness of the Air, Snow and Hail; but the Manner of Generation of these Fruits of the Air, is foreign to my present Subject. When by the Weight of the Air the Vapours ascend highest, and are most intimately mix'd with the Air, the lower Region in which we breathe may be said to be dry in respect to human Bodies.

VII. Dew is another Ingredient of Air. Dew is not mere Water, but a Composition of all the watery, volatile, oily, saline Vapours, which exhale from the Earth, which, as long as they are agitated by the Sun, are not to be seen, but as soon as the Air cools, they become visible. The Air being a rare Body, cools much sooner than the Earth, which continues still to sweat out this Substance after the Sun is down; and by the Cold of the Night a great deal of it falls down again in the Form of Water; for you may observe, when there is no Wind, there is always to be seen a Coat of this Vapour near the  
Sur-



Surface of the Earth. This Dew is a Collection of all the Substances that transpire from that Spot of Earth, and consequently very different in different Places, which is the Reason (as the learned *Boerhaave* observes) that the Chymists can never agree about the Contents of it, because their Experiments are made upon the Dews of different Places, and consequently of different Contents. In some Places it contains highly volatile and explosive Particles, so that in Distillation it has broke the Glass; in others, it has stain'd the Glass with the Colours of the Rainbow, which nothing could take out. *May-Dew*, being let stand to putrify, will gather a fat Substance like Cream a-top, with Vegetables and Insects of different sorts; the Seeds of the one, and Eggs of the other being exhal'd. There is an Account of Dew falling, in some Places, in the Form of Butter, or Grease, which grows extremely fetid \*, so that the Analysis of the Dew of any Place may perhaps be the best Method of finding such Contents of the Soil as are

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\* Abridgment of the Philosophical Transactions, Vol. II.  
p. 143.

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within the Reach of the Heat of the Sun.

VIII. The Air likewise contains the watery Exhalations, with the fragrant and volatile Spirit of all Vegetables. Spicy Odours are smelt at great Distances from the Countries where the Spices grow. The Quantity of these Exhalations of Vegetables must be very considerable in Summer. By Experiments of the most ingenious and industrious Mr. *Hales*,

A Vine perspires in a Day,	$\frac{1}{191}$	} of an Inch over its whole Sur- face.
A Sun Flower;	$\frac{1}{165}$	
A Cabbage,	$\frac{1}{186}$	
An Apple-tree,	$\frac{1}{104}$	

Which is, at a Medium,  $\frac{1}{161}$  of an Inch in a Day, or a whole Inch in 161 Days, the Duration of the Summer. By an Experiment of the same ingenious Gentleman, a Hop-yard of an Acre of Ground perspires as much as would cover the whole Acre, an Inch in 101 Days. An Inch of this perspirable watery Substance rarify'd into Air, would make (as one might call it) a vegetable Atmosphere of 71 Feet high. In the Summer the Ground is cover'd over with Vegetables; even the Grass exposeth a great Surface to the Sun,  
and

and is not without Perspiration. The Heat arising from vegetable Perspiration is very sensible in a hot Day near a Field of Corn. Upon this single Account of the Perspiration of Vegetables, the Air of the Summer must be very different from that of the Winter. The Odours of some Plants have very sensible Effects upon many People. The Oils, Salts, Seeds, and the insensible Abrasions of Vegetables float in the Air. The Production of Plants in some Places, where the Plants were not indiginous, has puzzled Philosophers; perhaps it may be accounted for, from the two Methods of propagating Plants, the Seed and the Slip, both may float in the Air; as the Bigness of the Slip from whence the Plant is propagated is not determined, who can say but the insensible Abrasions of a Plant may produce it? This by the way.

IX. Earth is another Content of the Air; Earth, calcin'd, flies off into the Air; the Ashes of burning Mountains, in Vulcanos, will be carried to great Distances.

X. Salts of all kinds are another Ingredient of Air; fix'd fossile Salts may be digested, render'd volatile, and evaporate in Air. Markasites attract vitriolick

triolick Salts from the Air. Vitriol Stones must be expos'd to the Air to produce Vitriol. Alum, robb'd of its Salt, recovers it in the Air. There may be obtain'd nitrous Salts from old Walls, in most Places; the Air either supplying these Salts as an Ingredient, or producing them as an Agent. In some Countries the Air will corrode the Bricks and Tiles. In Places abounding with Markasites, vitriolick Salts disperse themselves through the Air, which has been observ'd to rot the Hangings of Rooms, and lie upon the Surface of the Ground like a white Efflorescence. There are in the Air likewise the Particles of all Minerals; Gold, the heaviest of them, can be render'd volatile, and Quicksilver likewise. \* All the Fumes which are rais'd by natural or artificial Fires vanish into Air. The poisonous Steams of Mines produce the same Effects as they would do in Distillations. All the Smoke of culinary Fires, and Steams of fermenting Liquors, vanish in the Air, and make up a Part of the Contents of that in which we breathe.

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\* Dr. Leister imagines Thunder to be produc'd by the Exhalations of the Pyrites. There is indeed something very remarkable in great Thunders, having sometimes chang'd the Polarity of the Needle.

XI. Another Ingredient of the Air is the perspirable Matter of Animals, the Perspiration of a Man is about  $\frac{1}{34}$  of an Inch in 24 Hours all over the Surface of the Body ; consequently one Inch in 34 Days. The Surface of the Skin of a middle-siz'd Man is about 15 square Feet, consequently the Surface of the Skins of 2904 such Men would cover an Acre of Ground, and the perspir'd Matter would cover that Acre of Ground 1 Inch deep in 34 Days, which rarify'd into Air would make over that Acre an Atmosphere of the Steams of their Bodies near 71 Foot high. The great Quantity of Animal Substances, which are in the Air, appears further from this, that all Excrements and all the Carcasses of Animals vanish into Air, of those that are burnt very soon, of those that are expos'd later, of those that are buried in length of time ; but all the Parts of the Carcasses at last vanish into Air, except perhaps a small Quantity of Bones into Earth. Eggs of Insects float in the Air \*. Flesh hung up by a Thread, where no Fly could come, was filled with Maggots. The Caterpillars and other Insects,

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\* Boerhaave,

which so suddenly eat up the Leaves of Trees, perhaps are produced by the Eggs of those Insects floating in the Air; at least one does not easily perceive how they could be lodg'd in the Plants themselves. In *Africa* there are Showers which affect the Bodies of Men with Rigors, the Drops are found to have Insects in them; and perhaps there are Insects in the Air invisible to human Eyes: One may observe in that part of a Room, which is illuminated with the Rays of the Sun, Flies sometimes darting like Hawks, as it were upon a Prey.

XII. Sulphurs arise from many Parts of the Earth in great Quantities; in Mines there are Fumes stinking, oily, inflammable. These sulphurous Exhalations combin'd with some Salts or metalline Particles produce Explosions, and all the Effects of Gunpowder in Earthquakes, Thunder, &c. There are Instances after Thunder of sulphurous burning Showers; some of these sulphurous Steams seem to rise by a projectile Motion to great Heights, so they do likewise *in vacuo* with a great Celerity. This appears by Meteors, such as that in the Year 1718, which Dr. *Halley* has prov'd by Observations to be 60 Miles high, of a Mile Diameter, and run 300 Miles in a Minute:

nute : There must have been Air to propagate the Sound of the Explosion of that Meteor which was heard in some Places. Tho' the Air at that Height was 30000 times rarer than that near the Surface of the Earth, it seems it was capable of producing Sounds. The Coruscations which have often of late appear'd in this Country, seem'd to be of the same Nature, particularly that remarkable one 1716. In those Coruscations one might observe the sulphurous Steams rise from the Earth with a projectile Motion, to a great Height, and being consum'd, have not discover'd any ill Effect upon human Bodies.

XIII. The Air near the Surface is charg'd with all those heterogeneous Particles, and many others not possible to enumerate ; and yet the wise Author of Nature has temper'd this heterogeneous Mixture, so as to make it salubrious to the Animals that live in it, except in a few accidental Cases ; and perhaps pure Air without any of those Contents is unfit to sustain Animals and Vegetables. To make this Element wholsom, the wise Author of Nature has so order'd that the whole Mass is never overcharg'd with those Contents. For Example, since human

man Bodies are so contriv'd, as not to bear Excesses of any kind, as too much Driness, or too much Fluidity, there is a constant Circulation of the Water in the Air, and the Air of any Place contains very near the same Quantity of it. The Action of the Sun, or the Sum of all its Force upon the same Surface of Land and Water, and the Heat of the Surface of the Earth within the Year, is pretty near uniform, and consequently the Quantity of Evaporation the same: The Air has a Power of imbibing and sustaining only a certain Quantity of this Water, and the Sum of the Quantity that falls from the Air over the whole Surface of the Earth, in Rain, Snow, or Hail, is the same, tho' by accidental Causes of Winds, and the Stoppage of the Clouds, by Tracts of Mountains, more of these Vapours may be carried, and fall in one Place than another. This Water is again carried by its natural Gravity in Streams to the Sea, and other Reservoirs of Water, and from thence again exhal'd; only there is left a sufficient Quantity for the Nutrition of Plants and Animals; the Moisture of whose Bodies is again exhal'd, and this Circulation is constantly maintain'd; only there remains one Doubt, that the solid Parts of Animals,  
Vege-



Vegetables, and perhaps of Fossils, being mostly produc'd from watery Fluids, and some Quantity of those solid Parts, not being by the common Powers of Nature, convertible again into Water, whether the Solids of the Earth do not gain upon the Fluids, the first increasing and the second decreasing? The Oeconomy is the same in the other Contents of the Air; the perspirable Matter of Vegetables and Animals, the Oils, Salts, and Sulphurs fall down again, and repair the Bodies that are on or near the Surface of the Earth.

XIV. Nature makes use of all possible ways, to preserve this heterogeneous Fluid in a wholsom State. The Ingredients are digested and attenuated by Heat; they are stirr'd and constantly agitated by Winds, which mix the Air of different Regions together; there are Fermentations succeeded by violent Motions and Explosions, in Lightning and Thunder, and imitable by the Mixture of like Ingredients in Chymical Operations. In those Storms the redundant and noxious sulphurous Particles are consum'd. There are Instances of some Places becoming habitable by Earthquakes and Inundations, that were not so before: The Perspiration of the Earth  
is

is by turns stopt, and restor'd; there are Congelations of the redundant Water Precipitations, and many other Operations unknown to Art, producing a great Variety of Effects. Air is the Instrument of all those Operations when perform'd by Art; and those heterogeneous Bodies act upon one another in the Air itself, by many unconceivable ways: Many Experiments and Observations demonstrate the mutual Action of Bodies floating in the Air upon their approach. Some Chymical Processes will succeed in one sort of Air; which will be attempted in vain in another: *Tartarus regeneratus* can be made only in a Laboratory, where they distil Vinegar. It is impossible to conceive the Result of all such Operations in a heterogeneous Mixture; Mankind may be sensible of their Effects, but can never know their Nature.

XV. Tho' Nature preserves the Mass of this Fluid in a wholesom State; it must necessarily happen, that the Air of particular Regions, Seasons, and Places may differ very much in their Proportions of the Mixture of the Ingredients enumerated; and such Air must affect human Bodies variously by such Excesses or Defects. Too great Moisture affects human Bodies with one Class of Diseases,  
and

and too great Driness with another : The Powers of Human Bodies being limited and intolerant of Excesses of any kind. Air replete with the Steams of Animals, especially of such as are rotting, has often produced pestilential Fevers in that Place, of which there are many Instances, as that mention'd by *Ambrose Paree* 1562, rais'd by Carcases thrown into a Ditch. Such have likewise been rais'd by great Quantities of dead Locusts, and by dead Whales. The Steams of great Quantities of corrupted Vegetables have produced the same Effects in their Neighbourhood. The Effluvia of human live Bodies are extremely corruptible; the Water in which human Creatures bathe, by keeping, smells cadaverous by N<sup>o</sup> xi. of this Chapter, less than Three Thousand human Creatures living within the compass of an Acre of Ground, would make an Atmosphere of their own Steams about 71 Feet high, which, if not carried away by Winds, would turn pestiferous in a moment; from whence it may be inferr'd, that the very first Consideration in building of Cities is to make them open, airy, and well perslated. Pestilential Constitutions have been often preceded by great Calms; from hence the Air of Prisons produceth

often mortal Distempers; and Ships Crews turn sickly in Bays and Harbours, which would be healthy in the open Sea: It ought to be the principal Care of such as attend Hospitals to give a thorough Passage to the Air. Since the putrescent Parts of Carcasses buried under Ground, by N<sup>o</sup> xi. are carried off, tho' slowly into the Air: Whether this is not an Objection against Burying in Churches? And whether it is not proper that all Burying Places should be without Cities in the open Air? By what was observ'd N<sup>o</sup> viii. the Air of the Summer differs considerably from that of Winter. In Summer the Air is replete with the perspirable Matter of Vegetables, abounding with volatile Spirits and Oils, which perhaps stimulates and exhilarates the Spirits; and that of some Plants is too powerful for some People, who cannot support the Smell of some of them.

XVI. It follows from Observations, N<sup>o</sup> xi. That the Air of great Cities differs considerably from that of the Country. There is more of the perspirable Matter of Animals, which is never entirely blown off; there is more of the Steams of culinary Fires. There is a smaller Perspiration of the Ground, by the Paving of the Streets, and consequently,

as the Steams are hurtful or wholsom. Less Effect from them in either Case; tho' the Air of the Country is brought into Cities by Winds, there is always less of the Steams of Vegetables in Cities than in the Country.

XVII. Of all Contents of Air none are more noxious to human Bodies than Sulphurs: The Steam of Charcoal suffocates in a Moment, therefore when sulphurous Steams are too redundant, nature sets them on fire by Lightning: Some People are sensibly affected by the Air, before Thunder and Hurricanes. In hot Countries the Benefit which the Inhabitants receive from Thunder-Storms abates the Terror of them. There are sulphurous Vapours which infect the Vegetables, and render the Grass unwholsom to the Cattle that feed upon it \*: Miners are often hurt by these Steams. Observations † made in some of the Mines in *Derbyshire*, describe four sorts of those Damps. The first the Miners call the common sort, perceiv'd at first by the Candles burning Orbicular, and the Flame lessening by Degrees, the

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\* Vid. Abridgment of Philosophical Transactions, Vol. II. p. 180.

† Abridgment of Philosophical Transactions, Vol. II. p. 375.

Effects of it upon human Bodies are Fainting, Convulsions, Suffocation; the second, is what they call the Pease-bloom Damp; which the Miners imagine is the Steam of a Vegetable, growing lower than the Level; the third is the most noxious: The Miners tell you, they see in the highest Part of the Roof, in those Passages which branch out from the main Groove, a round thing of the Bigness of a Football, with a Film or Skin about it, which when broken by accident, disperseth it self and suffocates all the Company. The Miners, who are but coarse Philosophers, reckon that is the Steam of their own Bodies; which is not impossible, for the Oil of this Steam may possibly produce this Film or Coat. The fourth is the fulminating Damp, resembling in its Nature and Effects Gunpowder, or that Matter which produceth Thunder; when this takes Fire it kills by Explosion as Thunder and Gunpowder: The Remedies of the Miners are the same, which Nature useth in like Cases, making Communication with the whole Mass of outward Air, by Shafts, Perflation with artificial Winds and Bellows, and setting fire to those sulphurous Steams, after which they are able to go on with their Work: There are likewise

wife in some deep Wells and Pits sulphurous Steams, which will take Fire with a Candle; in some the Sulphur is combin'd with Sal Ammoniack, which does not fulminate. Sulphur itself is not unfriendly to the Lungs; and the Exhalations from sulphurous Spots of Earth in the open Air, are recommended as wholesome as the Air about the City of *Naples*; but it must be considered, those are in the free and open Air, not too redundant, and perhaps unmix'd with other noxious Salts, which those above-mention'd may be replete with; it will appear in the following Part of this Discourse, that Sulphur destroys the Elasticity of the Air.

XVIII. Metalline acid Salts which perspire from certain Spots of the Earth, and by their Gravity rise only to a certain Height, are extremely noxious taken in by the Breath; they contract the Vesicles, or immediately coagulate the Blood in the Capillary Vessels, which creep along the Surfaces of the Vesicles of the Lungs; which have very thin Coats, and are in immediate Contact with the outward Air; such is that mortiferous Steam in the *Grotto del Cani* near *Naples*.

XIX. Some have imagin'd the Plague to proceed from invifible Insects. This

System agrees with many of the Appearances in the Progress or Manner of Propagation of that Disease; but is altogether inconsistent with others. These are a few obvious Inferences, relating to our Subject, drawn from the Consideration of the Contents of the Air; and considering it as a heterogenous Body, many others of the same kind may be made, which the Brevity in this Essay will not admit: I proceed to the Consideration of the Properties of the Air.

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## C H A P. II.

### *Of the Properties of Air.*

I. **T**HE first Property of Air is Fluidity, which by no Power of Art or Nature yet known can be destroy'd; it preserves its Fluidity in Cold 44 Degrees greater than any Natural Cold: The Sparkling, which *Boerhaave* observ'd in Air illuminated by the Rays of the Sun, and which he at first imagin'd to proceed from some Congelation of the Air, he afterwards discover'd to proceed from watery Particles floating in the Air. No Condensation, Fermentation,



tion, nor Coagulation of Mixtures, where Air resides, have ever destroy'd its Fluidity, which Quality is absolutely necessary to an Element, in which Vegetables and Animals grow. No Vegetable nor Animal can expand its Fibres, in their Natural Figure, but in a Fluid that resists equally the Elongation of its Fibres: The Pressure of the Atmosphere keeps both Vegetables and animal Fibres within certain Limits of Accretion; it being always Fluid, the Pressure is equal upon every Part of their Surfaces. Therefore if you would give a human Creature the due Figure which Nature affects, it must be kept as free as possible from the Pressure of any hard Body: Human Creatures by being a great Part of their time upon their Feet, which is but a small Part of the Surface of the whole Body, acquire a better Shape, and the Feet by bearing the Pressure of the whole Body, grows Callous; if a human Creature were always recumbent it would not take its Natural Figure. Confinement by Stays or strait Clothes must spoil or change the natural Shape: Water being a Fluid much denser than Air, admits, supports and keeps together the Bodies of larger Animals than Air can do.

II. The Particles of Air are not discernible by a Microscope, tho' they may be larger than the Particles of Light ; they do not reflect it in vifual Angles.

III. Notwithstanding the Minuteness of the Particles of Air, many denser Fluids will pass where it cannot ; Oil will enter through Leather, which excludes Air.

IV. Lubricity or Divisibility by the smallest Force, is another Property of Air, by which Animals move in it, without much Resistance ; if there were Experiments of the Swiftnefs of the Motion of Birds and Fishes, one could determine the Proportion of their Force. Birds and Fishes move through their respective Element after the same manner : Fishes are the Birds of the Water. Fishes pass through an Element 800 times denser than Air, upon which Account they must employ a Force proportional to the greater Resistance of the Mediums : on the other hand a great Part of the Force of Birds is employ'd to support their Bodies in a much rarer Medium, whereas the Bodies of Fishes are equilibrated with the Water in which they swim. Yet the Air has some Degree of Tenacity, whereby the Parts attract one another, as appears by the spherical  
Figure

Figure of Bubbles, which attract and run into one another. At the same time by their Elasticity the Particles of Air in other Circumstances seem to have a Power of Repulsion or Flying off from one another; those two Properties are consistent as we see in Light.

V. The Resistance of Air is very considerable in Bodies mov'd swiftly through it, or by its swift Motion against Bodies: The Resistance in the first Case increaseth in the Duplicate Proportion of the Celerity of the moving Body, that is, the Resistance is 100 times greater when the Celerity is but ten times; so therefore if light Bodies be moved with a great Velocity, the Resistance of the Air will throw them back in another Direction. Air mov'd with Rapidity in violent Winds, has very sensible Effects upon human Bodies; we see the powerful Effects of a large Surface of Air or Wind, in moving great Bodies and turning Engines: A Stream of Air of 7 square Feet, near the half of the Surface of a human Body, moved with a Velocity of a great Wind or 22 Feet in a Second of Time, presseth against a human Body with a Force equal to Water mov'd  $1\frac{1}{2}$  Feet in a Minute, to which, if you add the Celerity of the Person  
moving

moving opposite, the Pressure is very considerable; so that riding or walking against great Winds is a great Exercise; the Effects of which are Redness and Inflammation of the Parts exposed to the Air, all the Effects of a soft Press or Verberation, Heat and Drowsiness.

VI. Gravity is another Property of Air, whereby it counterpoises a Column of Mercury from  $27\frac{1}{2}$  Inches to  $30\frac{1}{2}$ , the Gravity of the Atmosphere varying  $\frac{1}{15}$ , which are its utmost Limits; so that the exact specific Gravity of the Air cannot be determin'd. When the Barometer stands at 30 Inches, with a moderate Heat of the Weather, the specific Gravity of the Air is to that of Water about 1 to 800, and to that of Mercury as 1 to 10800. Dr. *Halley's* Account of the Causes of these Variations of the Gravity of the Air seems very satisfactory; for they must either proceed from the Air in one Time and Place, being charg'd with greater or lesser Quantities of ponderous Contents; which, by what is said in the foregoing Chapter, it imbibes plentifully, or from being accumulated more in one Place than another: The Air's being accumulated more in one Place than another, must proceed from the Currents of Air or Winds; thus contrary

trary Currents of Air tending to the same Place, must accumulate the Air in that Place, and consequently raise the Mercury in the Barometer, as a Westerly Wind in the *Atlantick*, and an Easterly in the *German Ocean*: Two Currents of Air from the same Place, must sink the Air in that Place, and consequently the Mercury in the Barometer: This is very possible in Liquids, and happens even in the Motion of the Tides; if there was always a perfect Calm, the *Æquilibrium* could only be charg'd by the greater or smaller Quantity of ponderous Contents; in confirmation of this System it is found, where the Winds are not variable, as near the Line, the Alterations of the Baroscope are very small: These Alterations of the Gravity of the Air cannot proceed from its letting fall its ponderous Contents, as in great Showers. It is true, that a heavy Body falling thro' a Fluid, during its Descent, does not press upon it, but by the Resistance which the Fluid gives to its Motion in Descent; but the Decrease of the Weight of the Atmosphere during the Fall of Rain, Snow, or Hail, is not proportional to this Cause, nor can be accounted for from it.

VII. The Air being fluid and heavy, presseth equally upon the Surface of a  
Human

Human Body, with a Weight equal to a Column of Mercury, whose Basis is equal to the Surface of a Human Body; and Altitude, that of the Barometer, perhaps in a middle-siz'd Man, with a Weight of 32000 Pounds, as it is possible for the Air to vary  $\frac{1}{10}$  in its Weight, such a Human Body must be pressed with 3200 Pound Weight more at one time than another; and if the Height of the Mercury varies only one Inch, there is the Difference of above 1000 Pounds. Such Alterations affect both the Fluids and Solids very sensibly; but as the Counterpoise between the Air within and that without the Body, is quickly restor'd by the free Communication that is between them, these Alterations are suffered without any sensible Inconvenience; and this indeed proves the ready Admission of the external Air into the Vessels of the Body, and the Escape of aerial Particles within the Body, in each Case of the Alteration of the Gravity of the external Air, from less to more, or more to less; for if this *Æquilibrium* was not kept between the external Air, and that within the Body, both the Fibres and Fluids being elastick, in the Case of an Increase of the Gravity of the external Air, the Fluids and Solids would  
be

be too much compress'd ; and in the Case of a Decrease of this Gravity, would expand themselves with a dolorous Sensation, and Danger to the Life of the Animal. A Fall of the Mercury in the Barometer is the same with the Exsuction of so much Air in an Air-Pump, in which Case we perceive the Fluids and Solids expand themselves, and the Animal swells. I have observ'd very sensible Effects of sudden Falls of the Mercury in the Barometer in tender People, and all the Symptoms they would have felt by the Exsuction of so much Air in an Air-Pump : Animals in the Air-Pump are relieved of their Symptoms in a great measure, by voiding of Air or Wind out of their Bodies ; therefore, if these Alterations of the Air were very sudden, and to great Degrees, they would produce very great and troublesome Symptoms in Human Bodies. As the Case stands now, the Variations of the Gravity of the Air keep both the Solids and the Fluids in an oscillatory Motion, synchronous, and proportional to their Changes, and which, by the different Degrees of Tension of the Fibres, and Expansion of the Fluids, must necessarily affect Human Bodies variously, and produce Alterations, of which the Inhabitants

bitants of Countries where the Mercury in the Barometer stands at the same Height, are not sensible ; but of this more afterwards.

VIII. Air is a Fluid in constant Motion : One may perceive in that Part of a Room which is illuminated by the Sunbeams entring at a small Hole, the Bodies floating in the Air are in continual Motion ; a constant undulatory Motion is perceiv'd by looking through Telescopes : These Undulations of the Air affect small and tender Bodies, yet not so much as to alter their Figures ; when the Air enters or escapes out of Bodies, it does not divide itself at first into its minutest Particles, but gathers into Bubbles ; and the Nature of Air is such, that the smallest Quantity of it has the Force of the whole Atmosphere, by the Spring or Elasticity ; of which in the next Article. If Air Bubbles are generated in the Cavities of the Vessels of Human Bodies, they must produce prodigious Effects.

IX. Air is likewise compressible and elastick : It can be compress'd into Spaces reciprocally proportional to the incumbent Weights, and expands itself again in Proportion as the compressing Force is remov'd : If the Weights compressing be as 1, 2, 3, the Spaces into which the



## *Effects of Air on Human Bodies.*

31

the Air is compress'd will be as 1,  $\frac{1}{2}$ ,  $\frac{1}{4}$ , consequently the Density of the Air will increase in direct Proportion to the compressing Weights; therefore, as you approach towards the Surface of the Earth, the Density of the Air increaseth, because of the greater Height of the Column of incumbent Air; as you go higher, the Air expands itself, and grows rarer, by the Force of its Spring or Elasticity, having so much of the incumbent Weight taken off. Were the whole Air of equal Density, the Atmosphere would not much exceed the Height of 5 Miles, and in the Ascent of 900 Foot the Mercury would sink 1 Inch, and so on: But, as I said before, the Expansion of the Air increasing, that is, the Air growing rarer as the incumbent Weight is taken off, an Ascent of 915 Feet from the Surface of the Earth sinks the Mercury 1 Inch; but as you ascend higher, it requires a greater Space of this thinner Air to make the Mercury sink another Inch, and that is found to be 1862 Feet, or more than double the former Height; and to sink the Mercury 3 Inches requires an Ascent of 2844, which is more than triple of 915; the Height of 1 Mile is requir'd to sink the Mercury 5.32, that is about 5 Inches and  $\frac{1}{3}$  of an Inch;

Inch; at 3 Miles high the Mercury will be reduc'd from 30 Inches to 16.68 Inches, that is 16 Inches, and near  $\frac{7}{10}$  of an Inch, the Height answering to an Inch of Mercury, still increasing in a Proportion determin'd by an easy Geometrical Calculation; of which it would be impertinent to say more, because it is equally useless to those who do, or do not understand Geometry, repeating to the first what they know already, and endeavouring to teach the others what they cannot comprehend.

X. From the different Density of the Air in higher or lower Regions, the same Effects are produced upon the Inhabitants of these Regions, as by the Variations of the Gravity of the Air above-mention'd.

XI. The Elasticity of the Air is a Force equal to its Gravity; for, as I said, the smallest Bubble of Air by its Elasticity will counterpoise the whole Atmosphere of equal Density: By those two Qualities of Gravity and Elasticity, and the Variations of them, the Air produceth great Effects upon Human Bodies; by these, Respiration is performed, and the Balance kept between the external Air and that within the Vessels of the Body: Yet I cannot but observe that  
there

there is something very hard to be understood in the Gravity and Elasticity of the Air. Suppose Air is in specifick Gravity to Water as 1 to 800: If there be  $\frac{1}{800}$  of Water in Air, the Air itself must weigh nothing; because so much Water is equiponderant with the same Quantity of Water. I have seen a Summer Shower of long Duration, which has filled a Tub 3 Inches perpendicular; 33 Feet of Water weighs equally with the whole Atmosphere, 3 Inches of Water is  $\frac{1}{4}$  of  $\frac{1}{33}$  or  $\frac{1}{132}$  of the Weight of the whole Atmosphere, much more than  $\frac{1}{800}$ . It would seem, that so great a Quantity of Water could not be at once in the Air of that Place, but must have been collected in Clouds from a great Quantity of Air. Water is mix'd with Air in the Form of Smoke, which is perhaps a Collection of Bubbles, with a viscuous Coat of Water about them, and are lighter than Air; but still there is so much Water in the Air whatever Form it is in, besides Water there are a great many other Contents in the Air specifically heavier than Air; if the Proportion of those Contents is not extremely small, Air itself must weigh nothing. Then as to the Compressibility of Air, that must have certain Limits, and can never go  
D beyond

beyond the Quantity of Water, and other incompressible Substances that are in Air. The Rarity and Density of Air has likewise its Bounds; for if the Law of Expansion obtain'd constantly, a Globe of Air of an Inch Diameter, at the Distance of a Semidiameter of the Earth, would fill all the Space of the Planetary Regions further than the Sphere of *Saturn*: As to the Density of the Air, suppose a Tube, or, as the Miners call it, a Shaft were sunk from the Surface of the Earth to the Centre within the Surface of the Earth, the Gravity of Bodies is as the Distance from the Centre; yet according to the Laws of Density, by a Computation too long to insert here, at 50 Miles deep, Air would be denser than Mercury, and near the Centre infinitely denser than Gold. This is an impossible Supposition; and all the Air above and within the Earth, of the Density of Mercury, wou'd not compose a Ring round the Surface of the Earth, of perhaps a Yard high. Therefore the Compressibility, Density and Rarity of the Air have Limits which they cannot exceed.

XII. True Air never loseth its Elasticity, tho' it exerts it only when collected into a Mass by its Elasticity; it insinuates itself in the Spaces of Liquors not sufficiently

ciently saturated with Air; and there it remains divided in its minutest Parts, as it were in a fix'd State; but when it is expanded by Heat, or the incumbent Pressure is taken off, it is collected in greater Masses, and exerts its Elasticity in Proportion to the Diminution of the incumbent Pressure.

XIII. Animal Fluids and Solids contain more Air in them in Proportion than perhaps any other Substances. \* Hartshorn will yield  $\frac{1}{7}$  of its whole Substance or 234 times its Bulk in Air. A human Calculus can be almost all evaporated by Fire. Animal Fluids do not contain so much Air as the Solids; but they contain a greater Proportion of Air than other watery Fluids. Blood contains  $\frac{1}{27}$  Part of its Weight in Air, and 33 times its Bulk; whereas 54 Inches of Well-Water yield but 1 Inch of Air: Supposing the Specific Gravity of Water to be to that of Air as 800 to 1, Water contains only  $\frac{1}{800}$  of its Weight in Air. *Bristol-Water* and *Holt Water* yield much the same Proportion as common Water, but *Pymont-Water* double the Quantity; the Activity of Chalybeat Water is owing to

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\* Mr. Hales.

some Aerial Particles in them; when these are evaporated, they are insipid and without any Virtue. By the Quantity of Air, which Blood and other animal Fluids contain, they expand themselves to a great Degree in an exhausted Receiver. Therefore the Variation of the Gravity and Elasticity of the Air, which proportionally expand and dilate the Liquors, with which the external Air communicates, must have sensible Effects upon animal Fluids, as Air is a principal Instrument in all the animal Oeconomy; and therefore a principal Ingredient in the Composition of animal Substances. It must in a particular manner affect animal Bodies, and variously by its Changes influence all their Operations. This only in general.

XIV. Air of double Density has double the Force; for if Air of a certain Density keeps up the Mercury in the Barometer 28 Inches, the same Capacity fill'd with Air of a double Density will keep it up 56 Inches. Heat increaseth the Elasticity of the Air.

XV. The Heat of boiling Water will augment the Force of the Spring of the Air  $\frac{1}{3}$ , if the Air is shut up; or expand it into  $\frac{1}{3}$  more of Space if it is at Liberty; if the Air be doubly dense, the  
same

same Degree of Heat acts with a double Force upon it. For Example, if common Air keeps up the Mercury in the Barometer at 30 Inches, the Heat of boiling Water will increase its Force  $\frac{1}{3}$ , and make it sustain the Mercury at 40 Inches; but if Air is doubly denser, the Augmentation of the Spring by the same Degree of Heat would be 20 Inches, and such an Air with double the Density, and the same Degree of Heat, would sustain the Mercury 80 Inches, 60 upon account of its double Density, and 20 which is the Augmentation of  $\frac{1}{3}$  of the Force by Heat; so that denser Air heated must have great Effects, such as subterraneous Air in great Depths. For Example, Air 100 times denser with the Heat of boiling Water, would have above 133 times the Force of common Air. The Heat of boiling Water will increase the Force of the Air, or expand it  $\frac{1}{3}$  more; but greater Heats, as that of melting Iron, such as may happen in subterraneous Places, would produce much greater Effects. The greatest Alteration of the Density of the Air, by the Difference of Heat and Cold in our Climate, does not exceed  $\frac{1}{8}$ , which is indeed very considerable. This by Mr. *Hauksbee's* Experiment; but there are others, in which the Differ-

ence is greater. Cold likewise increaseth the Elasticity of the Air by increasing its Density or Weight, to which its elastical Force is proportional. We shall treat more fully, in the following Part of this Essay, of these Qualities of the Air, of Heat, Cold, Moisture and Driness, and as they are combin'd with its Properties of Gravity and Elasticity, and of their Effects on Human Bodies.

XVI. By what has been said of the Elasticity of the Air, and which the smallest Mass of it passeth, so as to be able to resist the Pressure of the whole incumbent Atmosphere, one may perceive the great Force of hot and elastick Air in the Cavities of Human Bodies; whither Air-Bubbles may be generated in the Vessels of Human Bodies, I shall not positively determine. Strong Probabilities for the affirmative are, that Air-Bubbles are apt to get into Pipes which carry any Fluid even into those which carry Water; and their Effects are well known. It is likewise certain, and what I have known by frequent Experience, that there are Pains in the Extremities of the Body, which seems flatulent; and I have often perceived by Friction of these Parts immense Quantities of Wind to come out of the Stomach by Belching,  
by



by which the Patient was reliev'd. Air is not ty'd to the Laws of Circulation, but will break out wherever it can have a Vent; the Force of an Air-Bubble to produce Tension and Pain is sufficient. By what is said,

XVII. It seems likewise probable that Spasms and Convulsions are produced by hot and elastick Air, or Steams pent up. The Symptoms of Animals shut up in an exhausted Receiver are Convulsions; and as soon as those Animals have voided Air, through all the Emissaries of their Bodies, so as to bring the Air within their Vessels to a Balance with the outward rarer Air of the Recipient, they seem to recover for a Moment, till by a new Exsuction of Air, they relapse into the same Condition, as I observed before: Some tender human Creatures are apt to fall into Lipothymies upon a sudden Fall of the Mercury in the Barometer, which puts them in the same Case with the first Exsuction of Air in the Air-Pump.

XVIII. Human Creatures can live in Air of very different Densities; the Air in the same Place may differ  $\frac{1}{10}$  in Density or Weight, so much being the Variation of the Height of the Mercury; but what is more strange, Human Creatures can live in Airs where the Difference of

the Denſities is double : in the Bottom of Mines, where the Mercury ſtands at 32 Inches ; and at the Top of the higheſt Mountains, which ſuppoſing them to be 3 Miles of perpendicular Height, the Mercury muſt ſtand at a little above 16 Inches.

XIX. Though human Creatures can ſupport ſuch a Difference of Preſſure, as in the common Variation of Gravity in the ſame Place, makes the Difference of Preſſure upon a Body of an ordinary Size 3600 Pound Weight, and in the Difference of Altitude in the Bottom of Mines, and at the Tops of the higheſt Mountains, the Difference of 18 000 Weight ; yet ſuch a Difference of Preſſure muſt produce great Difference in the Tenſion of the Fibres, and Expansion of the Fluids of a Human Body. In the Caſe of a greater Weight, the Fibres being more ſtrongly brac'd and the Fluids more compacted, and, as I obſerv'd before, were there not a free Communication between the external Air, and the Air within the animal Fluids, theſe Changes would be inſupportable ; and the Animal would be in the ſame Caſe as in an Air-Pump with the Exſuction of half the Air ; in which Caſe the Blood would boil up and expand itſelf to a great Degree by ſo much  
of

of the Pressure of the external Air being taken off. All this is prevented by the quick Expulsion and Admission of the Air within and without the Body.

XX. It seems probable that the Diminution of the Force of the Pressure of the external Air, in bracing the Fibres, must create a Debility in muscular Motion, which is the Reason that some People have imagined they breath'd shorter than usual in ascending the Tops of high Mountains; but the true Reason is, that by the Diminution of the Pressure of the Air upon the Muscles, less Exercise puts one out of Breath; and perhaps the Overbalance of the Air within the Thorax may have some Effect. But then it may be objected, That Mountaineers are not less active and strong than the Inhabitants of low Countries: To which I answer, That there are two Causes which hinder this Effect; the first is the Excess of Coldness of the Air on the Tops of Mountains, above that of lower Situations, which counterbalanceth the less Weight, and braceth the Fibres more strongly; by reason of this Excess of Coldness in greater Altitudes, the Decrease of the Densities of the Air does not precisely answer Calculation: Another Reason seems

seems to be this, That such as live in a rarer Air, are habituated to the Exercise of a greater muscular Strength; they are as it were in the Case of Birds, which, performing their Motions in a rarer Medium, must always use a greater muscular Strength, which, tho' indeed Nature has endued them with the very Habit of using it, must strengthen their Fibres. A tame Bird cannot fly so well as a wild one.

XXI. The Pressure of the Air upon the Lungs is much less than it has been computed by some; but still it is something, and the Alteration of  $\frac{1}{10}$  of its Force upon the Lungs must produce some Difference in elutriating the Blood as it passeth through the Lungs, which are the chief Instruments of Sanguification. The Variations of the Pressure of the Air, in its Gravity and Elasticity, must produce proportional oscillatory Motions in the Fluids and Solids of Human Bodies; and when the Excursions are extreme and frequent, such great Agitations of the Fluids and Solids may produce great Alterations in Human Bodies; for which there is no need to have Recourse to occult Qualities in the Air. There's a Sort of Torture (if I remember right) used by the  
*Inquisition,*

*Inquisition*, which, by sweathing the Body very hard, and immediately unbracing it, will produce a most exquisite Pain and feverish Symptoms. The Air, by the Softness of its Contact, does not hurt animal Fibres much, but the bracing and unbracing the Fibres strongly by Turns may produce Changes analogous to this Torture; and such Alterations are producible not only by the Variations of the Gravity and Elasticity, but by the Qualities of Heat, Cold, Moisture, and Driness; of which I shall say something in the following Chapter.

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### C H A P. III.

#### *Of the Qualities of the Air.*

I. I CALL Fluidity, Gravity, Elasticity, &c. Properties of the Air, residing constantly in the whole Mass, and every Part of it. Heat, Cold, Driness, and Moisture, I choose to term Qualities, because, taken in the vulgar Sense, they are variable, and do not constantly inhere in the Whole, nor in the Parts.

II. The Air, by these variable Qualities of Heat, Cold, Driness, and Moisture,

sture, must necessarily produce great Variety of Changes in Human Bodies. Let us conceive a Fluid permanently warm, as Human Blood, inclos'd in a System of Tubes, thin, flexible, to which the outward Air has admittance by innumerable Passages: Let us conceive this System, with its inclos'd Fluid, steaming and reeking hot through innumerable Passages, changing Situation, sometimes within, sometimes without Doors, and expos'd to the cold, hot, dry, wet Air, and all the Variety of Changes which happen in that Element; the Changes which must happen to this System or Machine in these Circumstances, are not the twentieth Part of what happens to Human Bodies; which, besides the real Influence of the circumambient Air, is affected by the Changes with a dolorous or pleasant Sensation, which it has not always in its Power to avoid or enjoy.

III. Heat and Cold are Qualities relative to our Senses; and Cold perhaps only a Privation or less Degree of Heat or Motion. The Spirit of Wine in Thermometers being affected with the smallest Changes of Heat and Cold, is a proper Index of these Alterations, though the Degrees mark'd in the Tubes are not the exact Measures of the Quantity of them:

them: However, waving the Imperfections of that Instrument, I shall only advertise the Reader, that in my Observations of the Degrees of the Heat of the Air, I refer to those made by two Thermometers, *Farenheit's*, and one invented by Mr. *Hales*, fitted to Observations upon his Subject. In *Farenheit's* Thermometer, at 32 Degrees, the Water in the Air begins to freeze, which is known by hoar Frosts; the Cold increasing will sink the Spirit to 5 Degrees; and it has been known to sink it to 0 by Cold, in which scarce any Animal could live; by common artificial Cold it can be sunk 4 Degrees below 0; and by an uncommon Experiment has been sunk 40 Degrees below 0. The Air is temperate at 46 Degrees, and by natural Heat seldom reaches 90; and if you by artificial Heat raise it 122 Degrees more, so as to reach 212, this is the Heat of boiling Water; so that 252 is the Distance between the greatest artificial Cold, and the Heat of boiling Water; and 207 Degrees the Distance between the greatest natural Cold common in this Climate, and the Heat of boiling Water by this Thermometer. The natural Heat of an adult Person is 92, and of Children 94. No  
Animal

Animal can live long in an Air of 90, or near the natural Heat of the Body.

IV. Mr. *Hales's* Thermometer is chiefly contriv'd for Experiments of Vegetation. He begins his 0 at the first Degree of Cold, or the freezing Point; and his last Degree of Heat is that in which melted Wax, swimming on hot Water, begins to coagulate; the Space between those two Extremes he divides into 100 Degrees, justly reckoning that a Heat which keeps Wax fluid, is too strong for Vegetation. Human Heat can expand the Spirit of Wine  $\frac{1}{20}$ , when the Air is in a freezing Condition.

V. By Mr. *Hales's* Thermometer the Heat of animal Blood is to that of boiling Water, as  $14\frac{3}{11}$  to 33. By the same Thermometer the Heat of the Skin is 54 Degrees of the 100, the Point at which Wax begins to coagulate, and is somewhat more than that of Water in which you can put your Hand. This Heat no Vegetable can bear, at least in this Climate; tho' I remember Mr. *Boyle* mentions Heat in some Country which melts Wax, which is unsupportable by Human Bodies, and yet Vegetables survive it. By *Hales's* Thermometer, the Heat of Milk from the Cow is 55, of  
Urine



Urine 58; that of an extreme hot Day was 88; a common Sunshine Day at Noon, in *July*, 50; in the Shade 38; of a *May* or *June* Day from 17 to 30, the most temperate for Vegetation, and therefore the properest perhaps for Human Bodies. What was most surprising was the Heat of 88, which exceeding 54, the natural animal Heat, Human Creatures could not have endured it long. He told me that it was extremely hot for a while, and his Thermometer stood in the Sun.

VI. The Rarity of the Air makes it more sensible of the Changes of Heat and Cold, than any other Fluid. The smallest Increase of Heat expands it, and the Abatement of that contracts it immediately in all its Parts: The Heat of boiling Water, as was mentioned before, expands it  $\frac{1}{3}$ . The Degrees of Expansion of the Air are not determinable, for the greatest Degree of Heat will not totally expel it; but by this continual Contractibility and Dilatibility, by different Degrees of Heat, the Air is kept in a constant Motion. The different Degrees of Heat create a proportional Expansion of Liquors, so as to make a sensible Alteration in their specifick Gravity; that of rectify'd Spirit of Wine  
about

about the Pole makes the Difference of  $\frac{1}{9}$  of its Bulk, and consequently of its Price, bought by Measure: \* Mercury can be condens'd by Cold, so as to be as heavy as Gold: By Heat, the Air contain'd in animal Fluids is expanded; for Glafs Bubbles in any Fluid, rise and fall with the Changes of Heat, as well as by those of the Gravity of the Air.

VIII. A certain Degree of Heat, not strong enough to dry or destroy animal Solids, lengthens and relaxes the Fibres; from whence proceed the Sensation of Faintishness and Debility in a hot Day: the Effect above-mentioned of Relaxation of the Fibres, and Expansion of the Fluids by Heat, are evident to the Sight and Touch, for the outward Parts of Human Bodies swell and are plumper in hot Weather than in cold. There are many Experiments which demonstrate the same thing, needless to be inserted.

VIII. Air extremely hot is capable of reducing animal Substances to a State of Putrefaction, and is particularly hurtful to the Lungs. Blood is cooler in the Veins than in the Arteries, and returns

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\* Boerhaave.

to the right Ventricle of the Heart, where it is still render'd cooler by a fresh Mixture of Chyle, which is cooler than Blood; but by the Circulation through the Lungs it is heated again to a Degree, so as to render it spumous. The Surface of the Vesicles of the Lungs is expos'd to the outward Air, which has a free Admittance to it. Refrigeration by cool Air is one, tho' not the principal Use of Air in Respiration; but when this outward Air is many Degrees hotter than the Substance of the Lungs, it must necessarily destroy and putrify both the Solids and Fluids: And this is found true by an Experiment; for in a Sugar-Baker's Drying-Room, where the Air was heated 146, or 54 beyond that of a Human Body, a Sparrow died in two Minutes, a Dog in 28 Minutes; but the most remarkable thing of all was, that the Dog voided a red *Saliva*, fœtid and putrid. We owe this luciferous Experiment to the industrious *Boerhaave*, from which many important Inferences may be drawn; for why might not this putrid *Saliva* of the Dog be infectious? Consequently it is possible for pestilential Distempers to begin from excessive Heats;

no Human Creature can live long in an Air hotter than their own Bodies.

IX. There are some Experiments which seem to indicate that Air, heated to a certain Degree beyond that of boiling Water cool'd again, and retaining all its common Properties of Gravity, Elasticity, loseth something, so as to render it unfit for Respiration: But I am apt to believe, with the ingenious Mr. *Hales*, that in the Experiments which were made, the Air was infected with the poisonous Steams of the Bodies through which it pass'd in heating; for the Air that passed through hot Glass did not kill Animals, as that which passed through Charcoal: But however, it is certain that Air heated with sulphureous Steams of Candles or animal Bodies, loseth some Part of its Elasticity, and becomes unfit for animal Functions, such as the Air in which People of Fashion pass a great deal of their time; but of this more afterwards.

X. Another great Effect of the Heat of the Air upon Human Bodies is, that by the Degrees of it the Quantity of Perspiration, sensible and insensible, is regulated. By Journals that have been kept it appears, that the Perspiration of  
*England*

*England* scarcely equals all the other Excretions, and that the Summer Perspiration is near double to that of Winter; whereas in *Paduan* Air, the Perspiration the Year round is to all the other Excretions as 5 to 3, and perhaps in hotter Countries the Proportion is greater. This must occasion a great Variety of Human Constitutions and Diseases, according to different Climates. The ferous Part of the Blood being carried off by Sweat or sensible Perspiration, which is much greater in hot Countries than in cold or temperate, must make the *Crassamentum* or red Cake of the Blood more; and a Physician who has practis'd in those Countries, has assur'd me that the Case is so, that the Blood is commonly black and dense when drawn. I have often been surpris'd that the Quantities of Spices, which the Inhabitants of hot Countries take, do not hurt them; but on the other hand I consider, that Nature is wise, and had not made those Plants indigenous, unless they were useful and necessary, perhaps for attenuating the Blood depriv'd of its Fluidity by the great Quantity of sensible Perspiration; and to recruit it with the volatile and oily Parts of which it is depriv'd,

both by sensible and insensible Perspiration.

XI. I would likewise observe, That the real Quantity of animal Fluid carried off by Perspiration, can never be known by Ponderation; for as it is plain that the outward Air enters the Pores of the Body, and is sometimes imbib'd or absorb'd by the Animal, the Quantity of perspirable Matter is only the Difference of the Excess of that beyond the Quantity of Air that is imbib'd; of this more in the following Part of this Chapter.

XII. Winds do not cool the Air by their Motion, but by bringing along with them the Air of cooler Regions. The Thermometer does not change by Winds, nor by the strongest Blast of a Bellows, unless it be blown through Ice, or any Body colder than the Air, and such a Blast will sink it. The rapid Motion of great Storms rather agitates and heats the Air; but Winds cool animal Bodies by driving away the hot Steam that surrounds them: Suppose the Heat of an animal Body to be 90, and the Heat of the Air 48, the animal Body by blowing off the hot Steam will be surrounded with an Atmosphere of 48, near the Half of its natural Heat taken

taken off in a Second of Time; therefore resting in a cool Air after Exercise may be the Cause of great Diseases, especially such as affect the Lungs, Inflammations, Asthmas, Catarrhs; this Change of their Atmosphere happening, as was said, every Second of Time, is the same thing as putting on a cold Suit of Clothes every such time,

XIII. On the other hand, as Human Bodies can be cool'd by Air cooler than their own Temperature, perhaps sooner than by any other Means, there is great Use to be made of temperating feverish Heat by outward Air, so that it be done with Safety; this is known by Experience in inflammatory Distempers, as in the Small-pox. No Liquor taken inwardly can cool Human Blood so soon as cool Air. Boiling Water is reduc'd to its own Temperature in a short time, by cool Air. Two Liquors of equal Density, and unequal Degrees of Heat, being mix'd in equal Quantities, reduce the Heat of the Whole immediately to half the Sum; for Example, boiling Water hot as 212 Pound, to an equal Quantity of Water cold, as 32, makes the Heat of the whole  $\frac{212+32}{2}=114$ .

A Liquor of less Density, such as Air,

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is indeed longer in producing this Effect; and Air cools the Blood by its Contact or Admission into the Surface of the Skin, or the Lungs. Innumerable Mischiefs arise from keeping the Air of the Room of a feverish Person too hot, by depriving the Patient of the Benefit of Refrigeration by cool Air; from the bad Effects of animal Steams, which spoil the Air, and destroy its Elasticity, as will appear by what is said afterwards, it is known by Experience that Patients in Fevers affect cool Air, and will use their utmost Efforts to come at it, even by getting out of Bed. I am of Opinion that renewing and cooling the Air in a Patient's Room, giving it a free Admission by opening the Door, the Bed-Curtains, and in some Cases the Windows, or letting it in by Pipes, changing the hot Atmosphere about him, so as not to disappoint the Intention of keeping up a due Quantity of Perspiration; and in general, the right Management of the Air is one of the chief Branches of a Regimen in inflammatory Distempers; and by the scrupulous Care of silly Nurses in this Particular, the Disease is often increas'd, lengthen'd, and proves fatal; and this Error is still more dangerous in



in vigorous, strict, and ponderous Bodies, than in lax; for Heat is detain'd in Proportion to the Density of Bodies.

XIV. The Effects of cold Air may be inferr'd from what has been said of hot Air; Cold being a Privation or Abatement of so many Degrees of Heat, induceth a proportional Diminution of the Effects of Heat or contrary Qualities. Cold Air is the immediate Cause of Freezing; it first begins in the Air by Congelation of the watery Particles in it; and the Effects of this Cold sometimes do not reach so far as the Surface of the Earth, so as to freeze the Water on it; as in Summer Hail, and Icy Showers, such as that which fell in *Somersetshire* and *Oxfordshire* in 1672; so destructive to Vegetables, \* the Surface of the Earth was not frozen. In *Farenheit's* Thermometer Freezing begins at 32, and increasing, will sink the Spirit of Wine to 0, which is a Degree scarcely supportable by animal Bodies: Artificial Freezing will sink it below that Point. Vegetables endure greater Degrees of Cold than Animals,

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\* Abridgement of Philosophical Transactions, Vol. II.  
p. 152.

and yet great Destruction is made of them by Winter's Cold sometimes, as that of 1684, and in some Countries 1708; because Human Creatures have Defences against the Injuries of the Air.

XV. Cold condenseth the Air proportional to the Degrees of it; it contracts animal Fibres and Fluids, which are denser as far as the Cold reacheth. In cold Weather Animals are really of less Dimensions. Cold braceth the Fibres not only by its condensing Quality, but likewise by congealing the Moisture of the Air, which relaxeth. Extreme Cold works on Human Bodies as a *Stimulus*, producing at first a pricking Sensation, and afterwards a glowing Heat, or a small Degree of an Inflammation in the Parts of the Body which are exposed to it. By bracing of the Fibres more strongly, condensing the Fluids, and stimulating, it produceth Strength and Activity, which is very sensible to some in clear frosty Weather. If the Effects of cold Air are so considerable upon the outward Surface of the Body, they may be much more so upon the Lungs, in which the Blood is much hotter, and the Coat very thin, in immediate Contact with the outward Air; and

and were it not that the warm Air is not intirely expell'd in Expiration, the Contact of the cold Air would be intolerable; and indeed the Effect of cold Air in producing Inflammations of the Lungs is very sensible, especially upon the blowing of cold North-westerly Winds in some of our Northern Plantations in the *West-Indies*, Cold condenseth all Fluids, except Water, which it rarifies to  $\frac{1}{2}$  of more Bulk; Ice emergeth so much out of Water: As Frost separates Air from Water, and collects it into Bubbles, it may be suspected that the small specifick Gravity of Ice is not owing to invifible Masses of Air in the Ice; for Air separated from any Liquor takes up a greater Space than in the Liquor, and consequently renders the same Aggregate of Air and Water specifically lighter. Perhaps this may solve the Difficulties Mr. *Boyle* had about this Matter. Freezing Cold contracts all others Liquors besides Water, as oleaginous Liquors and Spirits, as to make them specifically heavier: Air, it will condense  $\frac{1}{10}$ .

XVI. Cold, by contracting the Fibres of the Skin, and cooling the Blood too much in those Vessels which are exposed to the Air, suppresseth some of the  
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the groffer Parts of the perspirable Matter, by which many Salts which would evaporate in warm Air are retain'd; and likewise by a *Stimulus* the cold Air vellicates and inflames these vessels, producing Scurvies, with the most dismal Symptoms: Scurvy is the Disease of cold countries; the fatal Extremities of it one may see in the Journals of such as have been left to winter in *Greenland* and other cold Countries; the Cold that froze their spirituous Liquors had nearly the same Effect upon the Blood, reducing to a gangrenous State the animal Substances, Mortifications of their Limbs, Gums, the putrid Flesh being forc'd to be cut off, a total Inability of Chewing, Immobility, and intolerable Pains in many Parts of the Body, livid Spots and Blisters on their Skins; and, by retarding the Motion of the Blood, and Suppression of Perspiration, Giddiness, Sleepiness, Pains in the Bowels, Looseness, Bloody-fluxes; but what is very strange, seldom a Decay of Appetite: These were not intirely the Effect of Salt Provisions; besides, they had often fresh, both vegetable and animal; if living in such cold Countries be practicable, it must be so far under-ground as reacheth beyond the Frost, which seldom

## *Effects of Air on Human Bodies.*

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seldom pierceth above the Depth of 10 Feet. The Air in the Grotto of the Observatory of *Paris*, of 130 Feet deep, is equable and temperate: There is a certain Distance at which the natural Heat of the Earth is not destroy'd by the outward Air. Frost in such a Degree as does not congeal animal Fluids, may increase insensible Perspiration. Liquors lose their volatile Parts in frosty Weather more than in hot, by condensing the watery Parts, the Volatile fly off. Scents are not abated by Cold\*; but, as I said before, some of the grosser Salts are retain'd in Perspiration.

XVII. Extreme Cold and extreme Heat destroy or reduce to a gangrenous State animal Substances, with this Difference, that the Cold which produceth Mortifications in living Bodies, preserves the Dead from Putrefaction; for there must be a Concurrence of Heat and Motion in the animal Juices with the *Stimulus* of the Cold, to produce the Change; we cannot raise a Blister on a dead Body.

XVIII. The Interchanges of Heat and Cold, and the constant oscillatory Motions of Contraction and Dilatation pro-

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\* Vide Memoirs de l'Academ. de Science, 1709.

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duc'd by them, are necessary for the Oeconomy of Animals and Vegetables, but neither can bear the Extremities of them. In all Probability the same Degree of Heat has persisted about the Earth ever since the Creation; the Causes which produce it are the same. Animals and Vegetables have been produc'd, and continued to grow after the same manner, which is a Sign that the Heat has wrought after an uniform manner, and that the Quantity of it upon the Surface of the Earth has continued the same; it may be increas'd in particular Places, but when the *Pabulum* which produc'd it is consum'd, there is no more Heat communicated to the rest of the Matter. There does not seem to be any natural Cause for the Increase of Heat on the Body of the Earth, unless it be the Approach of a Comet. The Spots that appear and disappear on the Surface of the Sun, can make no great Alteration.

XIX. As to the Degrees of Heat, a Heat of 90, by *Farenheit's* Thermometer, turns the White of an Egg liquid, sanious, and putrid; a Heat of 200 will harden it. Vegetable Heat, in which Plants will live or grow, is from 1 to 80; animal Heat, terrestrial, from 40 to 94;  
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of Fishes that have Gills 34, and which can bear Heat to 60; but Fishes which have Lungs can bear Heat from 34 to 94. Water begins to grow hot at 94, and boils at 212. 600 is a melting Heat. A catoptrical or dioptrical Heat is superior to any, vitrifying the hardest Substances.

XX. The Effects of Moisture on the Air, both on Animals and Vegetables, are Relaxation of their Fibres; by many Experiments I have found that the single Fibres, both of Vegetables and Animals, are lengthened by Water or by moist Air; a Fiddle-string moisten'd with Water will sink a Note in a little Time, and consequently must be relaxed or lengthened  $\frac{1}{16}$ ; the Steam of hot Water will sink it a Note in 5 or 6 Minutes. That Moisture relaxeth is evident by daily Experience, of Paper, Vellum, a Drum, Leather. Vegetable or animal Fibres first moisten'd, and afterwards dry'd, contract more than before they were moisten'd. It must happen indeed that Water, insinuated into the Pores of any Body, increaseth its Dimensions; and perhaps by this Mechanism it shortens Ropes, by increasing their Thickness. A cold Bath makes a momentary Contraction of the Fibres by  
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the Cold, and the Sensation of which in live Bodies works as a *Stimulus*; but the Water itself would relax, and constantly does so, when its Degree of Heat is equal to that of our Bodies, and continuing long in cool Water, at last relaxeth. Swimming long dispirits more by the Relaxation of the Water, than Exercise. Water and Air produce Volatility or Putrefaction in Bodies, and still in a greater Degree if assisted by Heat. Moisture helps Air to insinuate itself into the Pores of Bodies. A Bladder will sooner burst than let Air pass when dry, but when moisten'd lets it easily pass. Moisture diminisheth the Elasticity of the Air; in rainy Weather the Air is less elastick. Thus Moisture relaxeth Human Fibres, by weakening the Spring of the Air. Dry Air either abates those Effects, or produceth their Contraries. Dry Air sucks up the volatile Oils of animal Bodies, by which means it influenceth Perspiration. Freezing Cold separates Air from Water; for as the Water freezeth, the Air appears in Bubbles, which are sometimes inclos'd in Ice.

XXI. To the Relaxation of the Fibres by moist Air, are owing a great many Symptoms which Human Bodies feel in moist



moist Weather (by which Relaxation they lose some of their Elasticity or Force for circulating the Fluids) especially those Aches and Pains which they feel in those Parts where the Circulation of the Juices is not perfect, as in Cicatrices of Wounds, luxated or bruised Parts. I wish I could thoroughly understand the Cause of a Corn's aching before Rain, from which I should be able to explain the Causes of all those Pains which affect some Bodies in wet Weather.

XXII. Moist Air is properly that which is overcharg'd with Vapours near the Surface of the Earth; and when those Vapours are rather in a falling than an ascending State, the Body of Air may contain more Water in it at other times; but, as was said before, the Water and Air are better mix'd, the Vapours are higher, and a less Quantity of them in Contact with our Bodies; we call Air in such a State, dry; the Air may be said to be sometimes in a State of imbibing, and sometimes in a State of precipitating its Water.

XXIII. The Effects of dry Air are contrary to these of moist, because they are an Abatement or Privation of them. Dry Air imbibes volatile animal Oils and  
Spirits,

Spirits, and consequently influences Perpiration. Great Driness may change the very Texture and Situation of the Pores of the Skin. Of the two, extreme dry Seasons have proved more dangerous to Human Bodies than wet. Our Bodies are not made to bear Extremities of any kind, but extreme Droughts have been found most dangerous to Human Bodies. All these foremention'd Properties and Qualities of the Air, Gravity, Elasticity, Heat, Cold, Moisture, Driness, act in their several Combinations on Human Bodies; and when their Actions conspire, the Effect produced is the Sum; when contrariwise, the Effect is the Difference of their Actions.

XXIV. Air, by the Properties and Qualities enumerated, must produce very sensible Changes in Human Bodies, because it not only operates by outward Contact, but we constantly imbibe it at all the Pores of the Body, which is evident by what has been said before; for if the Air had not a constant Admittance into the Body, how could the Balance of the external Air, and that within the Vessels, be so quickly restor'd; upon this the Life of the Animal depends, to balance the Air within and without the Body;  
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it requires indeed some time in descending in the Diving-Bell : there is one troublesome Sensation, and it is a strong Pressure upon the Membrane of the Ear, where it has not so ready an Admittance ; but changing the Density of the Air not too fast, by the free Communication of the denser outward Air and that of the Body, there is no Danger nor uneasy Sensation. The Skin of an Animal dry'd, or Leather, excludes Air ; but the Skins of live Animals are moist and oily, through which Air will pass. Wherever there are Emissaries, there are likewise absorbing Vessels. Many Bodies denser than Air, as Mercury, Cantharides, Garlick, enter the Pores of the Skin. While we perspire, we absorb the outward Air, and the Quantity of perspired Matter found by Ponderation, is only the Difference between that and the Air imbib'd ; so that after great Labour and Abstinence, which produces a Vacuity, and a great Diminution of Perspiration, it is possible that the Quantity of the Air absorb'd may exceed the perspired Matter ; This is true, if the Journals of Perspiration be faithful. In Dr. Keil's Journal there is an instance of a Person growing 18 Ounces more ponderous by absorbing Air. The People

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ple of *Newmarket*, who try the Methods of Wasting, affirm this to be true ; tho' I own I should be very glad to have it confirm'd by some faithful Trial. *Hippocrates* and *Galen* took the Doctrine of absorbing of Air for granted, and reason from it. This Quality of generating Air, and absorbing it at different times, has been demonstrated by the ingenious Mr. *Hales* in many Bodies, especially in Vegetables, by plain Experiments ; by which it appears that Air enters freely through the Bark, Steam, and Leaves, and all the outward Surface of Vegetables, which are sometimes not in a State of Perspiring, but in a State of imbibing Air, as in the Night. Another very remarkable thing is, that Air passeth easier through the Barks of old Trees than of young. 2. If by Driness, Shrinking, and Hardening, the Pores of the Skins of old People may not grow wider ? They are indeed more coreaceous, but Air passeth through dry Membranes when moisten'd. By an Experiment of the ingenious Professor *Mysschenberg*, it appears that Air transmitted through clavellated Ashes into an exhausted Receiver, loses Weight as it passes through them, and more or less, according to the Degree of Moisture in the Air. Volatile Salts, such  
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as those of Animals, do not generate, but absorb Air; and it is very probable that Human Bodies absorb the Water from the moist Air, as fixt, dry, alkaline Salts do; which will explain a great many Symptoms arising from cold and moist Air. Many great Effects must follow; and many sudden Changes may happen in Human Bodies, by absorbing outward Air with all its Qualities and Contents; nothing accounts more clearly for epidemical Diseases seizing Human Creatures inhabiting the same Tract of Earth, who have nothing in common that affects them, except Air; such as that epidemical Catarrhus Fever of 1728, and of this present Year; it could not proceed merely from the Suppression of Perspiration by Cold, the Weather having been felt colder at other times; besides, it is known by Experience, that the mere Suppression of Perspiration does not always produce a Catarrh, nor that keeping it up prevents one; it seems rather to be occasion'd by Effluvia, uncommon either in Quantity or Quality, infecting the Air.

## C H A P. IV.

*Of the Nature of Air in different Situations, Regions, and Seasons.*

I. **A**FTER having said something of the Contents, Properties, and Qualities of Air in general, and their Effects; it behoves us to take notice of its local and temporary Qualities, which may be deduc'd not only by Conjecture, but demonstrative Reason, from what has been said before. As to the Contents of Air, it is evident that they must differ according to the Nature of the Surface of the Earth or Water from which they exhale; and this Difference would be permanent in every Spot of the Surface of the terraqueous Globe, did not the whole Mass of Air communicate as a Fluid, and were not its Parts agitated and mix'd together by the Motion of Winds and other Methods of the wise Author of Nature: Yet the Mixture is not so perfect but it leaves some Difference in the Nature of the Air, sensible to the Inhabitants of the same Tract of Ground where the Exhalations are constant, and constantly mix'd with the Air. Dew is the Exhalation

lation of the Earth, return'd again, and precipitated upon it; consequently the Nature and Contents of the Dew of any Place, seem to be the best Mark of the Exhalations of the Soil of that Place. Dew, by Chymical Trials, yields different Contents, according to Places, as the Soil is watery, salt, unctuous, saline, mineral; and differs according to the Quantity of Heat by which it is rais'd, either from the Sun, or inward from the Earth. The local Qualities of the Air are more permanent in Calms, than in Winds: This is evident from Fogs, which are the Consequence of Calms; therefore the Air retains its local Qualities long in Mines. Grottos, Ditches, not perfused; and in Valleys longer than on the Tops of Mountains.

II. The Exhalations from great Surfaces of Water, as the Sea, are scarcely any thing but Water, the Sun neither acting upon the bottom, nor exhaling the Salt. Winds raise some of the Salt with the Spray, as has been known by Experience in great Storms; the Bars of Windows, and Iron, expos'd to the Sea Air, are apt to rust; this Salt is not unfriendly to Human Constitutions, but the great Mass of Ex-

halation is fresh Water ; and were it not for constant Winds which blow off the Coat of Vapours which invests the Sea, I am of opinion that Sea Air would be intolerable to Human Bodies.

III. The Contents of the Air must differ much in Frost, and open Weather : Great Frosts stop the Perspiration of the Earth, and consequently deprive the Air of the Ingredients of those Exhalations ; accordingly, it has been found by Experience, that when there are noxious Exhalations in the Air, the Case perhaps of pestilential Seasons, that they have been stop'd by Frost : Frost congeals and separates the Water from Air. On the other hand, in Thaws, the Perspiration of the Earth being restor'd, and its Exhalations more copious, frequently render such Seasons unhealthy ; such was the Constitution preceeding the last Plague of *London*, a hard Winter, sudden Thaw, a great Quantity of Water, upon the Ground, attended with Heat ; such an Air could not miss to produce great Sickness, wherein Mankind liv'd as it were in a wet Cellar, with a great Fire. Summer Air differs considerably from that of Winter, from the Air's being replete with the perspirable Matter of Vegetables. Rains, after great Droughts, must,



must, in some measure, produce the same Effect as Thaws after great Frosts. The Air of Cities differs from Country Air, for many Reasons. See Numb. VIII. XI. Chap. I.

IV. The Contents of the Air of any Place differ according to its Situation, in respect of adjacent Places, from whence the Air is brought by Winds: A high Ground, dry, and naturally healthy, bordering upon low marshy Ground, must necessarily be sickly, when the Winds blow over those Marshes; besides, high Grounds attract Vapours as they rise from low Grounds. In choosing Situations, not only the Nature of the Soil on which you build, but the Nature of the neighbouring Grounds and Soil is to be considered.

V. A rich fertile Soil, abounding with Variety of active, volatile, and unctuous Particles, with a considerable Degree of Heat, must necessarily produce inflammatory Distempers in Human Bodies; such are rich Meadow Grounds, upon the Banks of Rivers, which, with the increasing Heat of the Spring, bring Fevers, especially intermitting: Such rich Grounds, in very hot Climates, are extremely unhealthy, as we find by the Relations of Travellers. On the other hand,

a gravelly Soil, on the Banks of a running Stream, is generally healthy.

VI. Mountainous Places abound with watery Vapours. Hills attract Vapours; Woods attract Vapours, and stop the Perflation by Winds; yet chalky and gravelly high Grounds which have no unwholsom Perspiration, nor are in the neighbourhood of marshy and low Grounds, are generally healthy.

VII. Both the superficial Effluvia of the Earth, and those of Minerals, which lie lower, affect the Air, as is known by Experience: People who pass over Ground abounding with Mines are sensible of offensive Steams. The *Averni* in *Hungary* kill Animals, and also Birds that fly over them. Mr. Boyle is of Opinion that more Places abound with Minerals, especially Marcasites, than are suspected. Minerals must needs affect the Air, when they enter the very Substance of Plants, of which there are very few that have not Iron in them. The ascending Fumes from the Mines in *Devonshire*, have blasted all the Vegetables, as Grass, Fern, &c. All mineral Steams are not unwholsom; Mr. Boyle gives Instances of some that emit a sweet and refreshing Savour, as in a Mine in *Hungary*, affording an Ore call'd

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*Rot Gulden erts*, the Steam of which is so refreshing, that People choose to enjoy it in taking the Air. The Tinnars are not more unhealthy, nor shorter-liv'd, than other People. Limestone is reckon'd wholsom ; it is warm, and quickly dissolves Snow, and causes excellent and wholsom Grass. Mr. Boyle, from a white Earth, extracted a rich volatile Spirit. There are Methods to discover what Sorts of Steams are in the Air, which it may be of Importance sometimes to try.

VIII. The Methods which Mr. Boyle adviseth for discovering what Salts are in the Air, are, to expose such Bodies as are affected with those Salts ; as dy'd Silks of particular Colours, which will be tarnish'd with nitrous Salts : Preparations of Sulphur are blacken'd with vitriolick Salts ; to try what Alterations are made upon white Linen, freed from Sope and Lye, by Steams or Dews ; Experiments of Bodies discoloured, or otherwise affected by different Spirits ; Spirit of Nitre makes with Copper, a palish Blue ; Spirit of Salt, a Green ; Spirit of Urine, a deep Blue. In some Places, as in *Amsterdam*, Plate tarnishes soon. The Copper-Mines in *Sweden* affect the Silver that is near them, and make it black. In  
some

some Places Furniture rots, Metals rust. But I think there is no better way of judging of the Air of any Place, than by the Water which must necessarily imbibe the Salts, Sulphurs, and other Minerals, through which it flows; and when it is free from any Savour from those Substances, it is probable the Ground is so too. Sulphurous Steams, arising by subterraneous Heats, whiten the Waters of Springs, and are certain Prognosticks of an Earthquake; and I think it may be concluded, that where the Water is good, the Air is so likewise. Sulphur in the Air may be discover'd by Smell, as is perceiv'd in Vulcanos and Storms. Sulphureous Airs may be fir'd with a Candle.

IX. Moisture in the Air is discover'd by Hygrosopes: And an Air naturally moist discovers itself by its Effects upon Furniture, Plate, and several other Bodies; and is sometimes to that Degree in Thaws after great Frosts, as to wet the Staircase, Wainscot, Pictures, and other Furniture.

X. As to the Gravity and Elasticity of the Air, they decrease with the Height, as was mention'd Chap. II. and it seems almost incredible, that a Human Creature can live at the Bottom of a Mine,  
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with the Mercury at 32 Inches high ; and at the Top of a Mountain of three Miles, perpendicular Height, where the Mercury stands at 16, that is, with the Weight of the Atmosphere ; in the first Case at 32000 Pounds, and in the second at 16000 ; perhaps there are scarcely any Human Creatures who reside constantly in those Extremes : if there were such, there must be a great Diversity of Constitutions and Diseases ; but a smaller Difference in the Weight of the Air, must create a great Diversity of the Effects of the Air, on the Inhabitants of those different Regions.

XI. The Changes of the Gravity of the Air, affecting Human Bodies with oscillatory Motions of the Solids and Fluids, the more frequent and great those Changes are, the greater Effects they will have upon the Nerves and Spirits ; but so it is, that within the Tropicks, where there are no variable Winds, the Variations of the Height of the Mercury are but small ; from whence there must arise a Diversity of Tempers and Constitutions between the Inhabitants of small and great Latitudes, upon account of the greater Variableness of the Gravity of the Air : Of these Particulars we shall say more afterwards.

XII. The

XII. The Air, by Elasticity, concurring with its Gravity, insinuates itself into animal Bodies. There are Substances, which, mix'd with Air, abate and destroy some of its Elasticity, especially sulphureous Steams, as those of Candles, Animals, which render the Air unfit for Respiration. The Air in which such Steams reside, is very different from pure Air.

XIII. Heat, as far as it depends upon the Action of the Sun, is mensurable in different Climates. The Quantities of it have been geometrically determin'd by Dr. Halley\* : For Example, the Equinoctial Heat under the Line, is to the Equinoctial Heat in 60 Degrees of Latitude, as 2 to 1 ; to that of the Latitude of 50, somewhat less than 10 to 6. The Tropical Heat under the Line is less than in a Latitude of 50, nearly in the Proportion of 9 to 11. The Tropical Heat under the Line is the least of any Situation upon the Globe. The Tropical Heat under the Pole is greater than that under the Line, in the Proportion of 5 to 4 ; the Duration of the Sun above the Horizon, the whole 24 Hours, overbalancing the Difference of the Inclina-

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\* Abridgment of Philosoph. Transactions, Vol. II. p. 169.  
tions

tions of its Rays. In all appearance, if there was no Sun, the Fluids above the Surface of the Earth, or within a certain Depth of it, would be absolutely rigid and frozen, so that there would be no Fluid at all; perhaps the Air itself, without the Action of the Sun, would not continue fluid. The Fluids are so much frozen in great Latitudes, by the Absence of the Sun, that the Quantity of Heat is not sufficient, during its Stay, to melt them and warm the Atmosphere, which is kept cold by the Ice on the Surface of the Earth. Heat and Cold are retain'd longer in Bodies, in Proportion to their Densities.

XIV. There is a Crust of solid Ice round the Pole, perhaps for some Degrees, which, by a hard and cold Winter, may get more Ground than it loseth in the succeeding Summer, and, being carried by Winds, affects the Air of lesser Latitudes with great Coldness. The Neighbourhood of great Bodies of Ice, produce in great Tracts of Land greater and more lasting Degrees of Cold than are proportional to their Latitudes, and which never cease till that Ice is melted. The Cold in the Parallel of *London* is much greater in the *West-Indies*. The midland Countries of  
great

great Continents are colder than those that have the Sea Air. *Moscow*, in the same Latitude with *Edinburgh*, is much colder.

XV. The same Southern Latitudes are colder than the Northern, from an Astronomical Cause, which, if the Reader does not understand, he may take it in this Light: The Time from the Vernal Equinox to the Autumnal, is 9 Days more than from the Autumnal to the Vernal; consequently the Summer in our Hemisphere is 9 Days longer than that of Southern Latitudes, which Cause, working a vast Number of Years, must heat our Hemisphere more than the Southern. Dr. *Halley* met with a Sea unnavigable for Ice, in the Latitude of 51, in the Month of *January*, which is the same thing as Ice in our Seas in the Month of *July*.

XVI. It is plain, that the Degrees of Heat in several Places of the Earth, bear no regular Proportion to the Action of the Sun, which is uniform. The great Diversity of Seasons in the same Place, may perhaps depend, in some measure, upon some Action of the Sun upon the Earth, resembling the Operations of Chymistry, raising some subterraneous Steams of different Qualities  
and



and Quantities, at different times. In the Year 775, it is reported by an \* Historian, that the *Mediterranean* was frozen along the Coast to the Distance of 50 Leagues.

XVII. The Heat of the Air depends, in some measure, upon the Constitution and Temper of the Surface of the Earth, which in some Places retains Heat more than in others. Black Earth imbibes the Sun's Rays: Expose a black and a white marble Ball to the Sun Beams, in a clear hot Day, the white will be perfectly cool, while the black acquires a Heat that would roast an Egg. Sandy Ground, by reflecting the Sun-beams every way, heats the Air, is offensive to the Eyes; and, by the Heat of the Sand in some Countries, insufferable to the Feet. The Heat of the Island of *Ormus*, which lies beyond the Tropick of *Cancer*, is so intolerable at some time of the Day, by the Reflexion of the Sun-beams from the white Mountains of Salt, that the Inhabitants are forc'd to immerge themselves in Water.

XVIII. Hot Steams rising from the Surface of the Earth, heat the contiguous Air. The Heat of particular Days

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\* Glycus.

depends sometimes upon the Reflexion and Refraction of Sun-beams from Clouds, by the Laws of Catoptricks and Dioptricks. The greatest Degree of Heat is producible by Attrition. The Parts abraded by the Attrition of Flint and Steel, are Glafs, which is the utmost Effect of the Heat of a Burning-glass, and more quick : And it is possible that the greatest Degrees of Heat in the Air, as Storms and Thunder, may be produc'd by the Collision and Fall of Icy Bodies in the Air.

XIX. The Heat decreaseth with the Attitudes from the Surface of the Earth, it being less on the Tops of Mountains than in Valleys, because the Air being a Fluid extremely rare, retains Heat but a short time. The Incidence of the Rays of the Sun, does not create any lasting Heat in the Air. The Air, at a small Distance from the *Focus* of a Burning-glass, which vitrifies Metal, is not hotter than other Air. The Heat excited in the Air by the Rays of the Sun is immediately extinguish'd by intercepting them. In a Green-house, the Parts not touch'd by the reflected Rays of the Sun, grow rather cooler than outward Air. Dense Bodies retain Heat, excited by Sun-beams a longer Time, in Proportion to their Density.

Density, the Air not the smallest Instant, as on the Tops of Mountains, where it is depriv'd of the Heat and Reflexion from the Surface of the Earth. In the middle of the Torrid Zone, in the Island of *Ceylon*, as you ascend the Air grows still cooler. The Tops of Mountains, in very hot Countries, are cover'd with Snow. \* As you ascend from the *Red-Sea* in *Æthiopia*, the Air grows still more temperate, till on the Tops of Mountains it grows more unsufferable than the Heat in the Valleys. It is by hot Air, and not by the Action of the Sun, that Ice melts. The Heat of the Sun, in a clear frosty Day, has but a small Effect upon a Surface of Ice. *Joseph d'Acosta* tells us, that the Air in one very high Mountain of *Peru* is mortal, at the first Blast, and by its Coldness preserves the dead Bodies from Putrefaction. He tells us, that on the Top of the Mountain of *Peru*, perhaps the highest in the World, he and his Company were seiz'd with bilious Vomitings, perhaps from the Thinness, as well as Coldness of the Air.

XX. As the Air in higher Regions is colder, so it seems to begin there, and descend towards the Surface of the Earth ; it

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\* Ludolph.

affects the Water at the Top first, which, in extreme Frosts, will freeze to the Depth of 3 Inches in 24 Hours. The Supposition of Frost being produc'd by nitrous Particles in the Air, is not well supported; the Steams of Nitre have no greater Effects than those of other saline Liquors in producing Cold. Spirit of Nitre dissolves Ice. In general, the Supposition contradicts Experiments, where Nitre rather dissolves Ice than produceth it.

XXI. Mere Freezing is not the Measure of Cold, for it begins to freeze at 32; but the Cold may increase till it brings the rectify'd Spirit to 0, a Cold insufferable by Human Bodies, and in which the most spirituous Liquors freeze: The strongest Motion, and the greatest artificial Heat by Fires, can hardly preserve Human Bodies from freezing. The natural Heat of a Human Body is 90, and it can subsist in Degrees of Heat between less than 90, and somewhat above 0. As the Difference of the Gravity of the Air, which Human Bodies can sustain, is surprising; no less so are the Limits of Heat and Cold sufferable, by the help of Art and Custom; in Cold to 0, in the Thermometer; and in Heat beyond the Limits of 90 Degrees mentioned.

mentioned. There are some Countries, as in *Suagena*, in which Wax is melted tho' lock'd up in Cabinets ; where Bodies in Summer are excoriated by Heat, as in Northern by Cold ; Shoes are burnt as it were with a hot Iron : But Human Creatures must have some Means of defending themselves from those excessive Heats, else they could not live,

XXII. As the Heat decreaseth from the Surface of the Earth upwards, the Effects of Frost scarcely reach 10 Feet within the Surface, beyond that Depth the Heat is more uniform ; the Thermometer, at the Depth of 130 Feet, scarcely varying, except from accidental Causes from Substances within the Bowels of the Earth. By the Relations of some who have gone down great Depths into the Bottom of Mines, coming out of the warm Air descending a few Fathoms, they find themselves colder ; afterwards the Heat increaseth, as they go lower, so that the Labourers are forc'd to work in some Mines without their Clothes ; and no doubt this Heat is different, according to the Difference of those Mineral Substances. The Heat produc'd by the Action of the Sun in the superficial Parts of the Earth, is longer

in decreafing and increafing, than in the Air; or in the Surface; fo that the Sea-fons within the Surface of the Earth do not begin fo foon as in the open Air.

XXIII. Great Alterations are produced in the Temperature of the Air, as to Heat and Cold, by Winds; not by their Motion, but as they blow over hot or cold Grounds, and mix Air of a hotter or colder Temper, with the Air of that Place, which, as they add or fubtract Degrees of Heat, produce half the Sum: For Example, Air, hot as 80, mixing with Air hot as 40, makes Air hot as 60; Air, hot as 30, mix'd with Air of 40, makes Air hot at 35. There are hot Winds in *Africa*, which blow over fand'y Defarts, that kill even Elephants: On the other hand, a Northerly Wind, blowing at the moderate rate of 8 Miles an Hour, would bring the Air of the Pole to *London* in 12 Days; for this Reason, in hot Climates, on this fide the Line, Northern Winds are wholfom, and Southerly Winds bring Difcafes. The Sicknefs and Health of the Inhabitants of *Egypt*, keep regular Periods with thofe two Winds. The Air of any Place may be heated or cool'd to great Degrees, by Winds; for, as I obferv'd before,  
blowing

blowing with a Bellows the Air of the Room where the Thermometer stands, neither raises nor sinks it; but if you blow through hot Metal or Ice, the first raises and the second sinks it in a Moment. Winds cool Human Bodies, if they are cooler than the Atmosphere of perspirable Matter that surrounds them, by blowing off that hotter Atmosphere, and investing the Body with one somewhat cooler. The Sea and Land Breezes refresh the Air of Countries within the torrid Zone, and are extremely comfortable to the Inhabitants. Wherever the Air is extremely rarify'd by Heat, the neighbouring cooler Air rusheth in to restore the Balance. The Nights in hot Countries are often very cold, and upon that Account extremely dangerous to the Health of such as expose themselves to it. An Easterly Wind in this Country, blows fresh after the Sun is down; and after a hot Day, chills Human Bodies expos'd to it too much, often occasioning Fevers and other Diseases.

XXIV. In large Tracts of Land, there is a much greater Uniformity of the Weather than is commonly imagin'd; the Colds and Heats differ as to their Degrees, but begin and end much about

the same time: This is confirm'd by Journals of the Weather kept at *Upminster*, *Zurich*, and *Paris*; remarkable Changes of Weather happening at those Places, near the same time. The Changes of the Gravity of the Air are yet more uniform; the Mercury, by Observations, rising and falling about the same time at *Paris*, *Upminster*, *Dublin*, *Lancashire*. The Winds likewise, when they are strong, agree very well; when they are less violent, they differ, as depending upon local Causes. It appears likewise that the *Alpine* Snows have an Influence upon the Weather of *England*, as well as upon that of *Zurich*; the Weather being uniform in great Tracts of Grounds, makes the Diseases uniform likewise, which we have of late seen by plain Observations.

XXV. The Cold of some Winters in *Britain*, and some Parts adjacent, particularly 1708, has nearly equall'd, in its Effects, that of great Northern Latitudes, by destroying several Animals, as Fishes, and some sorts of Birds, which continued scarce for some Years afterwards\*; but most of all, Vegetables;

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\* Vid. Abridgment of Philosophical Transactions, Vol. I. p. 107.



and yet did not produce any great Mortality amongst Mankind, because of the artificial Defences Human Creatures use against extreme Cold: The Causes of those great Excursions of the Seasons into the Extremes of Cold and Heat, are very obscure, but seem rather to depend upon Effluvia that rise out of the Earth, than the Action of heavenly Bodies.

XXVI. As to Moisture and Driness, as far as they affect Human Bodies, they are to be considered only in the Region of the Air in which we live and breathe; wherever there is a Cloud, there is moist Air, or what would feel so to a Human Body; but if it is at such a Height as not to be contiguous, the Body is not affected with it.

XXVII. In dry Weather, the Water in the Air is intimately mix'd with it, and the Vapours being higher, do not affect Human Bodies with a Sensation of Moisture; but when watery Vapours ascend or descend in Masses, then they affect Human Bodies, and probably are imbib'd with the Air, which feels more moist when the Water is descending, than ascending; more when the Water is in small, than in great Drops; in meazling and soaking Rains, than in great

Showers: The Effects of Moisture are more sensible to Human Bodies before, than after great Showers.

XXVIII. The Quantity of Vapour rais'd, and the Quantity of Water precipitated from the Air, as I observed before, seems to be pretty uniform the Year round, over the Surface of the terraqueous Globe, perhaps about 22 Inches deep over the whole; but from accidental Causes it differs considerably as to Quantity, in different Places, and in the same Place in different Years. In a Period of Eight Years, the Quantity of Water fallen from the Clouds was observ'd to be,

	Inches.
At <i>Zurich</i> ,	22 $\frac{1}{2}$ .
At <i>Paris</i> ,	19.
At <i>Upminster</i> ,	19 $\frac{1}{4}$ .
At <i>Pisa</i> ,	43 $\frac{1}{4}$ .
At <i>Lancashire</i> ,	42 $\frac{1}{4}$ .

The Quantities vary in another Cycle, but the Proportions not so much. The Causes which vary the Quantities of Rain seem to be 1<sup>st</sup>. A wetter or more watery Surface, expos'd to the Action of Heat, by which the Vapours are rais'd. 2<sup>dly</sup>, Cold in the upper Regions of the Air, to condense those Vapours, which, when

when they grow too heavy, must fall down in the Form of Rain, Hail, and Snow; therefore a moist Surface of Earth, with a Succession of Heat and Cold, must necessarily occasion a rainy Season. 3dly. Winds, which vary the Quantity of Rain in a particular Place, by carrying the Clouds of one Place to another. Hills attract Vapours; and the Valleys near mountainous Places have generally great Quantities of Rain. As to the Moisture and Driness of Regions within the torrid Zone, the most general Rule is, That the Rain is greatest, when the Sun is nearest; and the Drought the greatest, when the Sun is most oblique: This *Joseph d'Acosta* affirms, tho' not without some Exceptions. In our Climate, the most copious Showers, with the biggest Drops, are in the Summer. Within the Tropick the rainy Season is what they call their Winter. There is perhaps a greater Quantity of Rain falls between the Tropicks, than in greater Latitudes. There are greater Rivers and Lakes, and by the greater Heat, greater Quantities of Vapours are rais'd. This freer Circulation of Water balanceth the great Heat, which, without Moisture, would render Human Bodies sickly, and the  
Ground

Ground unfruitful. The Moisture of a Season is not to be exactly estimated by the Quantity of Rain; for many rainy Days (during which the Weather may be said to be moist) do not often produce so great a Quantity of Rain, as one great Shower, succeeded by many dry Days; but the Changes wrought in Human Bodies are proportional to the Continuance of moist or dry Seasons. The Quantity of Water falling upon any Tract of Ground, may be estimated by the Condition of the Springs: where they fall, to be sure there has been wanting a sufficient Quantity of Water from the Clouds to supply them; and the Surface of the Earth is no doubt for that Reason drier, and supplies a smaller Quantity of Vapours. There is scarce any better Measure for the Moisture of the Surface of the Earth, the Quantity of Vapours, and in general the Moisture of the Season, than the Quantity of Water; and indeed this is, in Places under the Influence of variable Winds, very different in different Years; at *Upminster*, in the Year 1709, there fell of Rain more than 26 Inches; of Rain, in the Year 1714, less than  $11\frac{1}{2}$  Inches, above the Difference of 2 to 1; at

at *Paris*, in the Year 1693, there fell 24.18; in 1705, 14.82, a Difference of near 7 to 5. Great Excursions of the Seasons, as to Drought and Moisture, produce great Alterations in the Constitutions and Diseases of Mankind; and, as far as Observations reach, dry Seasons seem to be the most dangerous of the two; the Year 1714 was fatal to the Cattle for want of Water; but it was likewise unhealthy to Mankind, perhaps from the want of a due Quantity of Water in the Air.

XXIX. Moist Air insinuates itself into the Pores of the most compact Bodies; and, as was observ'd before, Human Bodies absorb it with Air; and perhaps a due Quantity of it is necessary for a right State both of the Fluids and Solids. A Sponge will increase  $\frac{1}{10}$  of its Weight, by the Moisture of Air, in spite of a Fire in the Room; but as the Fire diminisheth, it will acquire more Weight. Sheeps Leather imbibes the Moisture of the Air plentifully. Bones are susceptible of this Moisture. Rots amongst Sheep are occasion'd by excessive Moisture in the Air. By Hygroscopes, especially those made of Sponges, many useful Observations may be made as to the Weather, and its Influence  
on

on Human Bodies. By Hygroscopes it is observ'd, that Winds often abate the Moisture of the Air, by blowing away the Vapours from whence they are drying; and so likewise they increase the Quantity of Evaporation, by blowing away the Coat of Vapours which invests a Surface of Water, and letting a new one arise.

XXX. Moisture increaseth the Weight and Dimensions of vegetable Substances; and, as was observ'd, relaxeth all simple Fibres, both vegetable and animal; consequently from moist Air may be produc'd all the Diseases which proceed from Laxity of Fibres, and such must be the Diseases and Constitutions of moist Countries and moist Seasons: On the contrary, extremely dry Air sucks up the Moisture of animal Bodies, especially combin'd with Heat; Heat relaxeth, and combin'd with Moisture, still more: Of these Matters I shall treat afterwards.

XXXI. What I observ'd N<sup>o</sup>. VII. Chap. II. of the great Limits sufferable by Human Bodies, in the Weight of Air, is likewise true of the other Qualities of the Air: It is wonderful to observe one Creature, that is, Mankind, indigenous to so many different Climates. Generally speaking, the Animals of warm Countries cannot subsist in Cold. *African Animals*  
can

can hardly endure the Coldness of the open Air of *England*, which is too warm for Rain Deer ; yet a Human Creature can subsist in Air from under the Line, to perhaps 75 Degrees of Latitude. What makes the Difference between Mankind and other Animals is, that Mankind is assisted by many Contrivances of Art, to bear Extremities. Brutes, left to their own Choice, as far as they can procure their Ends by local Motion, choose the Countries and Climates most adapted to their Constitutions ; and so perhaps would a Human Creature, if he were left to his own Choice ; but he is in Society, and under Government, and subject to Passion, to which he sacrificeth the greatest Blessings of Health, and Life itself. There are likewise other Causes of Migrations of great Herds of Mankind, which is their swarming so as to overstock the Countries which they inhabit.

## C H A P. V.

*Of the Use and Effects of Air in Respiration.*

I. **I**N order to come at the clearest Light possible in this Enquiry, it is necessary to state Facts as they appear by Experiments and Observations. All Animals live in Air or Water; or sometimes in one, and sometimes in the other; therefore they may be call'd, Aereal, Aquatick, or Amphibious. All Animals have some Organ by which they draw in and expel, by turns, some of the Fluid in which they live, by which the Aereal draw in Air, and the Aquatick Water: In the Aereal, this Organ is call'd Lungs; in Fishes, Gills. Fishes which sometimes breathe Air, and cannot always live under Water, as the Cetaceous Kind, have Lungs, and not Gills.

II. No Animal which has once made use of this reciprocal Motion of Lungs or Gills, can live any considerable time without continuing the same.

III. Air is so necessary for the Life of every Animal, Aquatick, as well as Aereal, that without it Life is extinguish'd  
in



in more or less time, according to their different Structure.

IV. Fishes in the Air-pump, as the Air is drawn out of their Water, swell, emit Air-bubbles, swim on their Backs, and at last die ; but if fresh Air be again admitted before they are quite dead, the Symptoms vanish, and they recover. Some Fishes, as Carp, Tench, Eel, live longer in Air, than in Water without Air ; some of the testaceous and crustaceous Kinds, live very long in an exhausted Recipient ; Oysters have liv'd 24 Hours in an exhausted Recipient ; a Craw-fish may be kill'd in one. Aquatick Animals live longer without Air than the Amphibious, and the Amphibious longer than the Aereal ; and of these, some a longer, and some a shorter time, according to the Structure of their Lungs. \* A Duck holds out longer in an exhausted Receiver, than a Hen. A Viper can live  $2\frac{1}{2}$  Hours in an exhausted Receiver ; and a Frog as long ; a Snake 10 Hours ; when some of those Animals seem as they were dead, they revive upon the Readmission of fresh Air ; but no Animal revives that has been kept in a perfect *Vacuum*.

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\* *Vide* Philosophical Transactions.

V. Young Animals live longer in the Air-pump than adult ; a Kitling longer than a Cat ; as a *Fætus* in the Mother's Belly, or newly excluded, may live without Air before it has breath'd.

VI. The Symptoms which Animals feel in an exhausted Receiver, do not all proceed from the extreme Rarity or Want of Air to breathe ; but many of them from the Expansion of the Air in their Vessels, by taking off the incumbent Pressure, which throws them into Convulsions, from which they are reliev'd, as they emit Air out of their Bodies, as was observ'd before ; the Balance between the outward Air, and that within the Animal, must be preserv'd ; and if this Balance is too quickly chang'd for the Capacity of those Passages of Communication, between the external Air and the internal of the Animal, the Animal, during that time, must suffer. It was observ'd, that a Human Creature, changing its Situation by Degrees, can live in Air differing one half in Density ; but in an exhausted Recipient, sinking the Mercurial Gage 16 Inches, would throw a Human Creature into Convulsions by the Suddenness of the Change. Drowning kills Aereal Animals by depriving them of Air ; if the

the Air in Receivers could be exhausted all at once, Want of Air would kill in the same time as Drowning, which, in some Animals, is very short. Small Birds are kill'd by being kept under Water half a Minute; a Duck in 6 Minutes; yet even Water-fowl, tho' they can stay under Water longer than other Birds, by Particularities in their Structure, they do not bear the Want of Air much longer than other Birds.

VII. What is remarkable, not only in Respiration, but may perhaps take place in other Qualities of the Air, That Asfuefaction, or being accustom'd, makes Animals still endure those Experiments better and better. A Duck, us'd to an exhausted Receiver, can endure it longer than a fresh one. Another Fact, settled by a fair Experiment of the ingenious Mr. *Hales*, is, that the Lungs of Animals that die *in Vacuo*, are shrunk, and sink in Water like the Lungs of a *Fœtus*; yet the Lungs of an Animal that dy'd *in Vacuo*, being afterwards put into a Recipient, and the Air exhausted, swell.

VIII. As no Animal can live without Air, so none can live long in breathing the same individual Air. A Gal-

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lon of Air cannot supply a Human Creature 1 Minute: By an Experiment of the ingenious Mr. *Hales*, 74 cubical Inches of Air could not supply him Half a Minute without Uneasiness, and not 1 Minute without Danger of Suffocation; but if he had been shut up with a proportional Quantity of Air, which consequently must have been spoil'd, not only by the Steams of the Lungs, but of the whole Body, the same Quantity would not have supply'd him so long a time.

IX. The rarer the Air is, it is the sooner spoil'd. A Linnet can live in about Half a Gallon of Air for three Hours, sick, but not quite dead; but in Air of half the Density, not  $1\frac{1}{4}$  Hour: A Lark expired in  $4\frac{1}{2}$  Pints of Air, with  $\frac{3}{4}$  of it exhausted in  $1\frac{1}{2}$  Minute. Animals cannot live long in Air extremely rare. Rarity is the Want of so much Air.

X. The Lungs are the chief Instrument of Sanguification, working somewhat after the manner of a Press, churning and mixing together the Blood and Chyle, by a reciprocal Expansion and Dilatation, which cannot be perform'd without the Admission and Expulsion of fresh Air. A *Fœtus*, through which the Mother's Blood already elaborated,

borated, circulates, does not stand in need of such an Organ; but as soon as the Animal wants a proper Sanguification, he wants the Use of Lungs: Accordingly, as soon as the Infant is exposed to the Air, being out of the common Integuments, the least Motion of the Muscles of the Thorax and Diaphragm must change the Dimensions of the Cavity of the Thorax; upon the Enlargement of which, the Air enters by the Windpipe into the Cavity of the Lungs, which consists of a Congeries of Air-bladders, dilatable by the Admission; and contractable again by the Expulsion of Air; the whole Mechanism being nothing but that of a Pair of Bellows. By this Dilatation of the Lungs, the pulmonary Vessels are unfolded, and a new Passage for the Blood, from the right Ventricle of the Heart through the pulmonary Artery, is opened, and the *Foramen ovale*, by which the Blood pass'd from one Ventricle to the other, is shut by a Valve, and by degrees obliterated; by this Mechanism, the Blood resluent into the right Ventricle of the Heart, continues to circulate through the Lungs as long as Respiration, or the reciprocal Motion of Expansion and Contraction of the Lungs is continued; but

that ceasing, the Circulation through the Lungs, which begins with Respiration, must likewise end with it, and the Blood, in Quantity Half of that of the whole Body, is at this time depriv'd of its Passage by the *Foramen ovale*, and being stop't, the Animal must die. Thus the Animal being totally depriv'd of Air to perform Respiration, as in an exhausted Receiver, must die: The flaccid State of the Lungs, and their being more ponderous than Lungs in their natural State, as by N<sup>o</sup> VII. demonstrate this to be the Case, and that the Blood stagnates in the Vessels. The Blood-Vessels creep along the Surface of the Air-bladders, upon the Dilatation of the Air-bladders; they must be unfolded and lengthened, whereas in a collapsed State they are corrugated, and as it were folded; yet warm Water can be easily injected into the Lungs in a collapsed State.

XI. The Capacity of a Human Lungs full grown, or the Sum of the Capacity of all the Air-bladders, is at least 220 cubical Inches; for so much Air is possible to be taken in at one Inspiration, by an Experiment of the learned and accurate Dr. *Jurin*. The Quantity of Air taken in by a common Inspiration, is  
various

various in different Subjects and Times, but hardly reaches 40 Inches, perhaps at a Medium 20, at which Rate  $\frac{10}{11}$  Parts of the Cavity of the Lungs continue full of Air, or some other Fluid, after every Expiration. The Surface of the Vesicles of the Lungs of a Human Creature is much larger than the whole Surface of the Skin, by a Mensuration and Calculation of Mr. *Hales*. The Surface of the Lungs of a Calf bears a Proportion to that of its whole Body, as 10 to 1.

XII. The Blood in the Lungs is warmer than on the Surface of the Skin; the Coat of the Vessels extremely thin, and those expos'd to the outward Air; and yet the Perspiration from the Lungs is not half of that from the Skin. 2. What is the Reason of this small Proportion? Is the Air absorb'd? for the Quantity of Perspiration is the Difference between the Air absorb'd, and the Humour prepar'd. There are several things may be said for and against the Air's entering into the Blood-Vessels of the Lungs in Respiration. 1. From the flaccid State of the Lungs of Animals that die *in Vacuo*, it seems evident that the Lungs do not expand themselves

upon the Exsuction of the Air, consequently the Air is suck'd out or escapes through the Blood-Vessels of the Lungs ; else if retain'd, it would expand and swell them ; if the Air has a free Egress through the Coats of the Vessels of the Lungs, it may have a free Ingress. On the other hand, Attempts to force Air into the Blood-Vessels of the Lungs by the Wind-pipe, have prov'd unsuccessful, and the Lungs of Animals that die *in Vacuo*, afterwards swell in the Air-pump. Things may happen in a live Animal, which will not succeed in a dead one. Air will pass through any Membrane, when moist. The quick Restoration of the Balance of Air within and without Human Bodies, shews that there is a free Communication ; and it is probable that it is so in the Lungs, as well as in other Parts of the Body.

XIII. By N<sup>o</sup> VIII. of this Chapter, the Air is quickly spoil'd by the Fumes of the Lungs, so as to render it unfit for Respiration : This must happen from several Causes : the Grossness of the Vapours hinders the Ingress of the subtler Parts of the Air into the Vesicles, which are so small as hardly to be discern'd



discern'd by a Microscope. If there be any Salts in any sort of Fumes, they must contract the Vesicles, and perhaps the tainted Air may likewise affect the Lungs by its Heat. Another Cause is the Destruction of the Elasticity of the Air by sulphureous Steams. Animal Steams are sulphureous, and as such, inflammable. The Sensation felt upon breathing Air tainted already with your Breath, is like that after a strong Expiration, and the Lungs feel as they were much fall'n, the Air not entering into them by the Loss of Elasticity, by which it rusheth into any Vacuity; allowing 20 Inspirations for 1 Minute, and 20 cubical Inches of Air for every Inspiration, this would make 24000 cubical Inches of Air in an Hour; some of the elastick Power of the Air is destroy'd at every Inspiration by the sulphureous Vapours lodg'd amongst the Air-bladders; and supposing the same numerical Air to be inspired, the 24000 cubical Inches of Air would lose so much of its Elasticity as to render it unfit for Respiration.

XIV. Vapours absorb true Air, or destroy its elastick Force at a great Rate: But the Loss of Elasticity is not the sole Cause of Air tainted being un-

fit for Respiration. \* A Rat liv'd 14 Hours in 2024 Inches of Air, during which time  $\frac{1}{27}$  of the whole was absorb'd. A Cat 3 Months old, liv'd an Hour in 594 cubical Inches of Air, with the Loss of  $\frac{1}{35}$  of true Air; and 19 Parts in 20 of the Air of detoniz'd Nitre is destroy'd in 18 Days. The Air produc'd by Distillations, loses its Elasticity. Burning Matches destroy the Elasticity of the Air at a great Rate. The Air, generated from fermenting sulphureous Mixtures, is quickly absorb'd, as in burning of Filings of Iron and Brimstone, Antimony and Brimstone. The Lungs, and all the Parts of the Thorax, undoubtedly perspire; if this perspirable Matter retain'd any Elasticity, it would be a Counterpoise to the outward Air, and stop the Expansion of the Lungs, as much as a Wound in the Thorax stops the Respiration of that Lobe, till the outward Air is excluded. The Air therefore in the perspirable Matter of the Thorax is absorb'd, and the Steam is unelastick. Sulphureous Vapours destroy elastick Air only to a certain Degree, for when Air is saturated with Vapours to a certain Quantity, no

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\* Mr. Hales.

more elastick Air is absorb'd, which is a happy Contrivance of Nature, else the Air, for a great Extent, might be spoil'd with sulphureous Steams. But tho' the Elasticity of the Air is never totally destroy'd, the same once destroy'd is never recover'd, yet in some Cases this Absorption of Air will reach to a great Degree. The Suffocation of Animals and the Extinction of Candles in Mines, proceed from sulphureous Vapours. Mr. *Hales* has found out the best Expedients for preventing immediate Suffocation from tainted Air, and to enable a Man to sustain it a longer time, in Case of Necessity, which is by breathing through Mufflers, which imbibes these Vapours; and this answers Experience, for the Mufflers increase in Weight by the Vapours which they imbibe. Salts are likewise strong Imbibers of sulphureous Steams; therefore he combin'd both these Substances together, and by dipping his Mufflers in a Solution of Sea-Salt, Salt of Tartar, or White-wine Vinegar, he was able still to breathe longer in this tainted Air. Steams of Vinegar are reckon'd Antipestilential; and for the same Reason Salts may be so, by sucking up the noxious Vapours. In Salt Mines, great Numbers of People live in good Health, who never breathe the  
Air

Air above-ground: It seems likewise to follow from this Experiment, that a Room hung with some Woollen Manufacture, must be wholsom, by imbibing the Steams of Animals, Fire and Candles, or any noxious Vapours.

XV. From the foregoing Experiments, a natural Account may be given of the Sufferings of People who pass a long time in a Room overcharg'd with the Steams of Animals, Fire and Candles. A Gallon of Air is spoil'd by the Steams of the Breath in one Minute, so as to be unfit for Respiration; consequently a Hogshead or 63 Gallons, would not supply a Human Creature an Hour; if he was shut up in this Hogshead of Air, the Air would be tainted by the Steams of the whole Body in  $\frac{1}{3}$  of the Time, or about 20 Minutes: And I believe it answers Experience, that a Human Creature could not live in a Hogshead of the same Air 20 Minutes: consequently 500 People, shut up in a Room of 500 Hogsheads Capacity, so as to have no Communication with the outward Air, would be dead, or in Convulsions, and other fatal Symptoms, in 20 Minutes; or in a Room of 3000 Hogsheads Capacity, in 2 Hours: This is indeed never the Case; and there is always in every Room some  
Vents

Vents for the -inward Air, and Inlets for the outward Air ; notwithstanding which, the Air is much tainted, and tho' it is not fatal, it is hurtful. Ladies, and other tender People, pass a great Part of their Time in Rooms extremely well fitted up, so as to admit scarcely any outward Air, except by opening of Doors and Windows ; the Air of the Room is tainted very much with the Steams of Animals and Candles.

2. Whether some of their nervous Symptoms may not proceed from this Cause ? Fire and Candles taint the Air, a middle-siz'd Candle as much as a Human Creature, and are as soon extinct by sulphureous Steams, and by the Destruction of the elastick Force of the Air ; therefore Fire, fed by cool Air, burns most briskly, and most of all in a keen Frost : Heat, by weakening the Spring of the Air, abates the Force of Fire ; the Light of the Sun will put out a Fire ; and a small Fire will not burn near a large one.

\* Fire seems to be produc'd by the Action and Reaction of Sulphur and Air ; for Salt, Water, and Earth, are not inflammable. There is something analo-

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\* Mr. Hales.

gous to this in Human Creatures. Air, weaken'd in its Spring, is not so fit for Respiration, nor perhaps for any other animal Purposes. We find by Experience, that Asthmaticks cannot bear the Air of hot Rooms and Cities where there is a great deal of Fuel burnt, except in Summer, when the Consumption of Fuel is less.

XVI. As to the Force or Pressure of the outward Air upon the Lungs, it is not so great as has been calculated by some, whose Calculations have been rectify'd by one of Dr. Jurin's, who makes the Pressure of the Air upon the Lungs not much more than that of falling Dew. The Force of a Smith's Bellows will raise Mercury one Inch; a Bellows has but one Air-bladder, and a Human Lungs Millions; and it requires a greater Force to draw in and expel the Air, through a Capacity of 220 cubical Inches, distributed into Millions of little Cells, than through one Cell of the Capacity of 220 cubical Inches; the Friction in the first Case must be very considerable; it requires a considerable Force to move a Pair of Bellows of the Capacity of a Human Lungs, with a Nose of the Capacity of the Wind-pipe, and would require still more, if they were divided in-

to as many Cells as Human Lungs : Therefore it seems to me, that the Force of the Air upon the Lungs is at least  $\frac{1}{36}$  of the Weight of the Atmosphere ; but whatever be the Force of the Air upon the Lungs, it varies with its Gravity and Elasticity, consequently the Variation of those must have proportional Effects upon the Motion of the Blood through the Lungs : The Expansion of the Lungs by Respiration being necessary for the Circulation through the Lungs. The Circulation is more easy, in Proportion to that Expansion ; on the contrary, whatever stops the Circulation through the Lungs, must hinder the Dilatation, by which it is plain, Respiration must have an Influence upon the Pulse, as to Frequency, Strength, Hardness, or Softness : Whether it bears any Proportion as to Time, I leave to be determin'd by future Observations : As far as I have observ'd, the Frequency of a natural Pulse, is to that of Respiration, about 10 to 3 ; this I suggest only, as a Matter worth the inquiring into. Too great Repletion, or too great Emptiness of the Lungs, occasion a quick Pulse. The Increase of the Frequency of the Pulse in Animals dying by Loss of Blood, is a very curious Experiment of the ingenious

nious Mr. *Hales*. A smaller Quantity of Blood circulates with greater Ease through the Lungs; in which Case the Heart acts like a voluntary Agent, who when there is a less Weight of the Fluid to be forced through Pipes by pumping; is able to redouble its Strokes. The Experiments and Calculations about the Force of the Heart in propelling the Blood, do not determine its absolute Force, but only that which it exerts in that Circumstance: The Heart employs various Degrees of Force to carry on the Circulation, and preserve the Life of the Animal, according to the Quantity of Resistance: But whatever the Pressure of the Air is upon the Lungs, it is diminish'd and increas'd in Proportion to its Density. Some have suppos'd the Weight of the Atmosphere to be the Antagonist Force to the Muscles, which dilate the Thorax; but the Resistance of the Air to any Motion is so small, that it may be reckon'd nothing; and when the Inspiration is ended, the external Air, and that within the Lungs, are equally balanc'd, and the Air can have no Force in relaxing those Muscles. An ingenious Countryman of mine has given a Solution of this Motion of Restitution, which I have not yet examin'd.

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The Action of Respiration is in some measure subject to the Will, for it can be suspended for some time; and there are Instances, one at least, that I have heard, of a voluntary Suffocation, by holding the Breath. Respiration being carried on in Sleep is no Argument against its being Voluntary. What shall we say of the *Noctambulos*? There are voluntary Motions carried on without Thought, to avoid Pain.

XVII. The Causes of a faulty Respiration are multifarious; whatever creates any Degree of Immobility in the Thorax, as Stiffness in the Motion of the Ribs or Cartilages, and consequently abates the Quantity of its Dilatation, in Proportion to which, a smaller Quantity of Air must enter the Lungs: Fulness from any Cause, even from Wind in the lower Belly, which pressing upon the Diaphragm, resists its Contraction, by which the Cavity of the Thorax is enlarg'd; Repletion or Obstruction of the Vessels of the Lungs; Humidity of any kind, in the Cavity of the Air-bladders; Contraction of their Fibres from any saline *Stimulus*. These Causes, by diminishing the Cavity of the Air-bladders, must proportionally abate the Quantity of the Air inspir'd: Likewise all inflammatory and stimulating

ting Causes, which disturb the Motion of the Muscles, Membranes, and other Organs of Respiration; such are an Impediment to Respiration, by making a full Respiration painful. Lastly, Such Causes as arise from the Qualities of the Air, as sulphureous Steams, or too great Heat, which destroy its Elasticity, or render it too gross to enter the Air-bladders: Watery Vapours, the least Quantity of Water entering the Wind-pipe, must be immediately rejected by Coughing: Acid Mineral Steams, which immediately contract the Fibres of the *Bronchia*, and coagulate the Blood: and many others, too long to enumerate, but perhaps reducible to some of the abovemention'd Heads.

XVIII. Such as have a faulty Respiration, must necessarily have an imperfect Sanguification. The Blood of Asthmatics is viscid, and imperfectly mixt, being not sufficiently attenuated by the Action of the Lungs; and being imperfectly mixt, the serous Part is easily separated from the globular; for slow Motion approacheth to a quiescent State, in which the *Serum* is intirely separated from the *Crassamentum*. The secondary Uses of Air in Respiration, are to form the Voice and Speech, to perform Suction, or taking  
of

of Aliment, Expulsion of the *Fæces*, &c. refrigerate the Blood in the Lungs, by what was observ'd N<sup>o</sup> VIII. Chap. III. Animals cannot breathe Air much warmer than the natural Heat of their Body, for such Air reduceth their Fluids to a State of Putrefaction. If a Human Creature is depriv'd of this Refrigeration by cool Air for a Moment, by holding his Breath, he grows hot in Proportion; the whole Mass of Blood circulates through the Lungs in 10 Minutes; the Blood moves in the small Vessels of the Lungs 43 times faster than in the Capillaries of other Parts of the Body; the Attrition is greater in the Lungs than in any other of the *Viscera*, because the Lungs work as a Press, and are constantly kneading or churning the Blood; the Attrition of the Blood by the Surfaces of the capillary Vessels, through which it flows, is, *cæteris paribus*, in the inverse Proportion of the Diameters; but by this Attrition the Blood is retarded, and the Capillaries acquire a greater Plenitude, which serves many Purposes of Nature. Without this Refrigeration by cool Air, the Blood in the Lungs would grow extremely hot.

XIX. The Lungs of cold Animals, such as Serpents, Frogs, &c. consist of larger and less numerous Air-bladders,  
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than those of warm Animals, for which Reason, in these, the Attrition on the Lungs is greater, the Blood warmer, the Perspiration greater, and consequently a more constant Reparation by Aliment necessary. Serpents can live long without Aliment. A Degree of Heat, beyond that of the Element in which they live, is necessary for all Animals. The Blood of Fishes has some Degree of Warmth beyond that of the Water in which they live. A certain Degree of Heat is necessary to keep the Blood from coagulating, and too great a Degree of Heat actually coagulates; that of a Human Creature approaches very near the Degree of Coagulation. But this Heat of the Blood does not proceed merely from the saline sulphureous Parts that are in it, for Fishes have rather more Salt and Oil in their Blood, than terrestrial Animals. The Heat of the Blood is the Effect of Motion and Attrition of elastick Particles, and for that Reason is greater in the Lungs, than in any other Organ; no doubt the saline and oily Parts, of which the Blood consists, makes it more susceptible of Heat by Motion, than a mere watery Fluid.

XX. Tho' we have endeavour'd to explain the Use and Effects of Air in Respiration, as far as is obvious to our Senses,

Senses, and deducible from mechanical Principles, we are far from imagining that Air has not many Uses and Effects in the Animal Oeconomy, which we shall never be able to account for; and that there is in it some other vital Principle, which makes it so necessary for the Life of all Animals. Air convey'd by other Passages than the Lungs, as into the *Vena cava*, *Ductus Thoracicus*, and even by the *Anus* into the Intestines, will restore the Motion of the Heart in agonizing Animals. The Motion of the Hearts of Animals, cut out of their Bodies, and the Motion of Insects which continue some time after their Heads are cut off, cease *in Vacuo* immediately. *Hippocrates* imagin'd the Air to be the Principle of animal Motion \*. Animal Life is presently extinguish'd without Communication with the outward Air, and may instantly be restor'd by it. All Animals have some Passages to inspire the outward Air. Some Insects have their Windpipes on the Surface † of their Body, and are therefore kill'd by the Contact of Oil, not as a Poison, but as it excludes the Air. *Borelli* supposes that

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\* Lib. de Flatibus & Morbo sacro.

† Malpighius de Bombyce.

the Air inspir'd by an Oscillation depending upon its Elasticity, regulates the Animal Motions as a *Pendulum* of a Clock. This Hypothesis is subject to many Difficulties. Air in Liquors does not exert its Elasticity till collected in Masses; it has always the Power of exerting it, but till a certain Quantity of the incumbent Pressure is taken off, it continues in a fixed State, and divided into its minutest Parts. Many have endeavoured to explain this vital Force of Air, I think unsuccessfully; therefore I would advise such as deal in those Subjects to be contented to reason from the sensible Effects of Air, of which they are sure from Experience. The Lungs being of a lax delicate Texture, with a Surface of a larger Extent than of the whole Skin expos'd to the outward Air, and of a much hotter Temperature, must be extremely sensible of the Qualities of the outward Air, and affected by them as by outward Contact; therefore the Choice of Air to People of tender Lungs, is a Matter of great Importance: First, as to Humidity, the least Quantity of it must produce a Cough; as for hot Air, the Lungs cannot bear Air that is hotter than the Animal Fluids; Heat and Moisture together, produce  
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Putrefaction. Consumptive People often die in a hot Day: But those two Qualities seldom reside long in Air together. It ought likewise to be consider'd, that Heating-Rooms, by any Contrivance which does not let the Vapours escape, may be dangerous to the Lungs: On the contrary, Air intensely cold, by its Contact, may condense and coagulate the Blood, through the thin Coats of the Vessels, so as to produce Inflammations, which reign here in the Winter, and in many Countries upon cold Blasts. We have seen the Effects of some cold and moist Exhalations in two epidemical Cartarrhous Fevers. Air dry, and not intensely hot, must be favourable to the Lungs; accordingly Countries, where the Air has those Qualities, are pretty free from Pulmonick Consumptions.

XXI. Besides these sensible and variable Qualities of the Air, there may be saline Exhalations, which must affect the Lungs still in a greater Degree; not only contracting the Air-Bladders, but corroding the Solids, and coagulating the Fluids. It seems probable, that there are a great many such Exhalations in *Britain*, for it abounds with Mineral Waters; such as is the Water, such is the Air. The Air of *Holland* is more benign to

tender Lungs, than that of *England*, tho' it must necessarily be moister; but it is free from Mineral Steams, of which there are none in the Country. The Lungs being the chief Organ of Sanguification, good Air must help the second Digestion; and we often feel the Effects of good Air, as well in Stomachick as in Pectoral Cases. In short, Air has so great an Influence, both upon the Fluids and Solids of Human Bodies, that it is Matter of Experience that some People find themselves much disorder'd in one sort of Air and Weather, and perfectly well in another; the Cause of which Change is easily discoverable by any Person who understands the Physiology of Air, and the Constitution of the Patient; and for this single Reason, the Nature and Effects of Air are a very proper Subject of Study, because the Choice of it is often a necessary Part of Advice. The Effects of Air, when it enters the Thorax by an Aperture, are very much to be regarded in the Management of Wounds in the Thorax; for first, the Air which enters into the Thorax, is a Counterpoise to that which enters by Inspiration, and must stop the Expansion of that Lobe of the Lungs where the Aperture is. The Air entering into the Cavity of the  
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the Thorax, corrupts and converts into Pus, Blood, and other animal Juices. If there is a Communication through the Lungs with the Air, admitted by Respiration, it may produce bad Symptoms, and even Suffocation; tho' the Case seldom happens. It has therefore been the Practice of ~~A~~ judicious Chirurgeons, not to dress such Wounds with large Tents, which, amongst other Inconveniences, have that of admitting Air at every Dressing.

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C H A P. VI.

*Concerning the Influence of the Air on Human Constitutions and Diseases.*

I. **T**HOUGH I have given some general Observations and Reasonings on this Subject as I went on, in the foregoing Part of this Essay, yet I think it demands a particular Consideration. The Effects of the Air on Human Bodies are as various as the Diversity of the Weather, Climates and Countries. The Physiology of them is very obscure and imperfect, not only in that Part which will be always hard to find out,

*viz.* the different Qualities of Air, and the Manner of their Action upon Human Bodies; but in that likewise which lies within the Compass of Human Industry and Sagacity. A History of Facts, or a Journal of Diseases, compar'd with the Weather, which, if it should be kept for any great Period of Time, and in many Places, I will venture to affirm, that Mankind would arrive at more than a conjectural Knowledge in this Matter. The ancient Physicians seem to have been more attentive to this, than the Moderns; and those of the Moderns who have attended to it, have perhaps made no inconsiderable Figure in their Profession.

II. *Hippocrates* thinks it incumbent on a Physician \* to consider the Situation, Air, and Water of a City, in order to come at the Knowledge of their popular Diseases, and their Seasons; and his own Observations are very particular, and suppose the Attraction of Air by Human Bodies: For Instance, That Cities expos'd to the Sun and Winds being well perfused, at the same time supply'd with wholsom Water, are exempt from many

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\* De Aere, Locis & Aquis.

Diseases, which those in different Circumstances are subject to : That Cities in *Greece*, shut up from Northerly Winds, were unhealthy : That in a dry Summer Diseases end sooner than in a wet one, in which they are obstinate, and dispos'd to Suppurations, Heat and Moisture in the Air producing Putrefaction : That cold Air occasions Defluxions and Hoarseness : That serous Defluxions, and redundant Pituite, were the Product of the Winter, which made Women subject to Abortions, Children to Convulsions, and such as were expos'd to Cold subject to Inflammations of the Eyes and Lungs. This sagacious great Man pretends, that he could predict the Diseases from the Weather ; and contrariwise, That Heat ensuing upon a wet Season produceth serous Defluxions upon the Head and Belly, and acute Fevers : That cool Weather about the Dog-Days, if it is not succeeded by a temperate *Autumn*, is dangerous for Women and Children, producing Quartans, and the Consequence of them Dropsies : A mild rainy Winter, succeeded by Northerly Winds in the Spring, dangerous to childing Women, producing Defluxions on the Lungs, Colicks in the Phlegmatick, and Inflammations in the Bilious ; that Obstructions  
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after Relaxations occasion Palsies and sudden Death to old People: A rainy *Spring* and *Autumn* make a sickly Winter; burning Fevers in middle-ag'd People and Phlegmatick, Pleurifies and Inflammations of the Lungs in the Bilious: A dry Summer, with Northerly Winds, succeeded by a wet *Autumn*, Head-Aches, Apoplexies: A dry *Autumn* with Northerly Winds, profitable to Phlegmatick, but dangerous to Bilious Constitutions, because the watery Parts which dilute the Gall are absorb'd. No less judicious are all his Observations upon the Diseases of the Season of the Year, as they depend upon the Temperature of the Air. He adviseth to consider the Constitution of the Air in Chirurgical Operations; excepts against the *Solstices* in cutting for the Stone. What he says about the Equinoxes, and Rising and Setting of the Stars, seems to be fanciful, conformable to the Opinions of that Age. This great Man goes still further; he ascribes the different Shapes, Complexions, Tempers of Mankind, and even their different Forms of Government, to the Difference of the Constitution of the Air: That the fertile Countries of *Asia*, from moderate Heat and Moisture, produce Animals large and handsom: That the Mildness of their Climate

Climate disposeth them to be soft and effeminate, not enduring Labour and Hardship, like the *Greeks* (frequent Changes in the Body affecting the Mind) from thence the *Asiatics* are less bold and courageous, slavish, and subject to Masters, and therefore easily slide into Monarchies; that tho' they are forc'd, they are not willing to abandon their Ease and Families, or to hazard their Lives for the Power and Wealth of their Masters, in Expeditions from which themselves reap no Advantage: That on the other hand, the *Greeks* and Northern *Asiatics* were bold, hardy, and warlike; and being their own Masters, willingly underwent Dangers, of which they themselves reap the Advantage. Afterwards on the same Subject, he writes to this purpose: That as the Equability of the Temperature of the Air render'd the *Asiatics* lazy, the great Variety of Heat and Cold in *Europe*, by variously affecting the Body, likewise affected the Mind, rendering them active; Activity begetting Fortitude, and Fortitude begetting Laws to secure their Property, and being govern'd by Laws, they were susceptible of the Rewards and Fruits of their Industry, of which such as live under absolute

lute Monarchs are not. This good old Man seems to have been no Friend to Monarchy. The *Phasians*, says he, from the excessive Moisture of their Air, are tall, soft, bloated, pale; there can be no better Philosophy than this, for such Effects proceed from lax Fibres, and lax Fibres from excessive Moisture. Such as inhabit mountainous Places, are fierce and active; and contrariwise, the Inhabitants of fertile Plains, with stagnating Waters. Inhabitants of barren and dry Ground are proud and obstinate. A fat Soil produceth a fat Understanding. A barren Soil, with cold Winters, makes the Inhabitants hasty and warm in their Tempers, proud, and quick of Apprehension. In this Book, *De Flatibus*, (if it be his) he ascribes the Causes of all Distempers, especially of the Pestilential, to the Air. In his Book *De Morbo sacro*, he goes still further, and asserts, That Air gives Sensation, Life, and Motion to the Members.

III. His most excellent Books of epide-mical Diseases, are a History of Diseases, and the Weather from whence he drew many of the forementioned and other Observations; and through the whole, one may observe a great Conformity between the Constitution of the  
Air,

## *Effects of Air on Human Bodies.*

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Air, and that of Diseases, of which one could give not a few Instances. The Constitution of his first Section, a wet *Autumn*, dry Winter with Northerly Winds, a cold Spring, a mild Summer ; from whence he observ'd few Suppurations. The Constitution of his Second Section, a moist *Autumn*, a Winter moist and afterwards cold, a cold Northerly Spring ; the natural Product of such a cold moist Year, were Inflammations of the Eyes, Colicks, Fluxes of the Belly, great Fluidity, catarrhus Fevers, few continued Fevers, Tertians, Semi-Tertians, some Quartans, no great Thirst, or Hæmorrhages attending Fevers, Catarrhs, Defluxions upon the Joints ; in short, all the Effects of moist Air, imbib'd by Human Bodies. What seems remarkable in the Constitution of his Third Section, is an Excess of Drought, a dry cold Winter, Spring, and Summer : This Year was noted for Palsies, (as the last, after a great Drought, was in *London*) Dysenteries, Hæmorrhages of all sorts, the Effect of a Stricture of the Fibres from Cold and Drought, continued Fevers with Delirium and Thirst, the Diseases most dangerous to the Young and Vigorous ; great and repeated feverish Rigors, both  
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in Winter and Summer which were cold. In his Second Book he ascribes the great Rifenefs of Carbuncles in the Summer, to the great Heats; and observes, that Sweats ensued upon Showers, Moisture relaxing; that burning Fevers were most violent in a hot and dry Summer; that in constant Weather the Diseases are more uniform, and more easily resolv'd; and contrariwise, in variable Weather, that the Diseases of the Spring are least pernicious. In this Book he likewise observes, That a mild Winter, with Southerly Winds, a dry Spring, and a Summer with meazling Rains like Dew, were attended with Fevers, and Parotids, or Tumors behind the Ears. A sort of a Pestilential Season, describ'd in his Third Section of his Third Book, was a hard Winter, succeeded by a rainy warm Spring, and an extremely hot Summer, without Winds, not very unlike the Constitution of the Year of the Plague of *London*: This Year, describ'd by *Hippocrates*, was remarkable for all inflammatory Eruptions upon the Skin, and all Diseases of Putrefaction. In the Sixth Book he observes, That frequent Changes of the Winds from North to South, produce Inflammations of the Lungs; and in general, that the proper  
Weather



Weather of the Season, as it happens later or sooner, dry, cold, hot, with or without Winds, determine the Nature of the Diseases. These are a few Instances of the Sagacity and Industry of this great Man, and his great Application to this Part of his Profession, of the Influence of the Air upon Human Constitutions, in which, no question, he was assisted by the Observations of his Predecessors ; and I hope to shew in the Sequel of this Chapter, that a great many of his Observations, even those that seem most fanciful, depend upon natural Causes adequate to their Effects.

IV. As I observ'd before, the Subject of the Influence of Air upon the Constitutions and Diseases of Human Bodies, has not been treated of by modern Physicians, with that Accuracy it deserves ; Observations of that kind are but few, and there is no Series of them in any Country : What would give most Light into this Matter, is a Collection of Observations in Countries where both the Qualities of the Air have great Excursions towards Extremes, where the Seasons, and these Excursions, and the Diseases depending upon them, are regular : *Egypt* is a Country which answers all those Intentions in some Degree ;

gree; and it happens luckily, that a very eminent Physician, who liv'd some time and practis'd among them, has given us a very good Account, both of the Constitution of their Seasons, and their popular Diseases.

V. *Egypt* is situated between *Æthiopia*, the *Mediterranean* Sea, *Arabia*, and *Barbary*, which lie in the Order mention'd, South, North, East, and West of it. *Grand Cairo*, where *Prosper Alpinus* practis'd, lies in 30 Degrees Northern Latitude, as *Ptolemy* says, 6 Degrees beyond the Tropick of *Cancer*; who for that Reason must suppose the Angle of the Equator, with the Eclyptick, 24 Degrees 30 Minutes more than it is now observ'd to be. This great City is situated at the Foot of the Mountains of the *Stony Arabia*, which lie towards the East. It is quite expos'd to the Northerly Winds which blow over the *Mediterranean*: Towards the South there is a hot sandy Soil; so that the Alterations of Heat and Cold, as the Winds blow North and South over the *Mediterranean*, or over this hot Sand, are excessive; and the Alterations of Heat and Cold from the other Winds but small, lying near the Tropick; the Soil being sandy, and fructify'd only by the  
Slime

Slime of the *Nile*, without Rain; there is hardly any humid Perspiration from the Ground itself, the Air receiving Moisture only from the watery Surface of the *Nile*, during the Inundation, or from the Vapours brought from the *Mediterranean* by the Northerly Winds; From these Causes the Air is extremely hot, and the Tropical Heats would be insufferable, if it were not for the Northerly Winds; and indeed, the Heats are sometimes so vehement, that the Inhabitants defend themselves from them by many Contrivances, Fountains in the middle of their Houses, Pipes to convey fresh Air by Grottos, and high Edifices by which their Streets are shadow'd from the Sun, and a temperate Diet; and during the Tropical Heats, the Air is sometimes so much moisten'd and cool'd by the Northerly Winds, and the watery Surface of the *Nile*, that the acute and pestilential Distempers are check'd by this Constitution of the Air. The Inhabitants often suffer from Catarrhus Distempers, more than in Northern Countries, their Bodies being more delicate, and their Pores more open, by the preceding Heat. As to their Seasons, their Spring lasts from the Beginning of *January* to *March*; their Summer is  
K double;

double ; the First, from the Beginning of *March* to the *Solstice* ; and the Second, from the *Solstice* to the Beginning of *September* ; and this second Summer is more constant, healthy, and less scorching than the first, by reason of the Difference of the Winds, and other Causes after-mentioned. Their *Autumn* lasts *September* and *October* ; and their *Winter* *November* and *December*. The extreme Heat of the first Summer proceeds from the hot Winds which blow from the South and South-East, call'd by the Inhabitants *Campsin*, from their Continuance of 50 Days ; tho' they have no determin'd time, but last sometimes more than 3 Months, and reign commonly *March*, *April*, and *May* ; they blow over the Sands, which they raise in Clouds, sometimes so as to obscure the Sun : During this time, many epidemical Diseases rage, especially Inflammations of the Eyes ; a Fever, which the Inhabitants call *Demelmuia*, attended with a Delirium, and proves often mortal in a few Hours ; and even the Plague itself. This extreme Heat has sudden Interruptions of Cold, which makes the Inhabitants still more unhealthy. The Inhabitants, during the *Campsin*, live under Ground. The Heat, during the Months of *June* and

and *July*, which, by the Course of the Sun, should be the greatest, is so moderated by the Northerly and moist Winds blowing over the *Mediterranean*, and by the Overflowing of the *Nile*, that the Inhabitants grow healthy, and sow their Seed in the Months of *September* and *October*. Their Winter has seldom any Snow, Frost, or Rain, or any thing besides Dew; unless in some Places bordering upon the *Mediterranean*, and receiving Clouds from thence. So the reigning Winds in *Egypt* are the Southerly, blowing as it were from an Oven; and the Northerly moist and cold over the *Mediterranean*; and this last perhaps two Thirds of the Year, and during the greatest Solar Heats. Another Cause by which both the Heat and Drought of the Air is temper'd, is the Overflowing of the *Nile*, which rising in the Mountains of *Æthiopia*, bends its Course Northerly through a Tract of Land near 30 Degrees. By the Rains falling in those Mountains, the *Nile* has ever since the Memory of Man begun to swell the 17th of *June*, New Style: It riseth every Day about 8 or 10 Inches, and begins to fall in *August*; decreaseth till *May*, when it is in a manner stagnating. The Limits of its Height are, from 26 the

highest of all, to 18 the lowest, in Cubits; the middle 24; 18 is a Height barely sufficient to make an Inundation. Its Water not only refresheth the Air with a kindly Moisture, but is the most delicious Drink in the World, when purify'd by the Deposition of its Sediment, being of itself a Cure for most Distempers, where Dilution, a Diuresis or Sweating is necessary, which *Prosper Alpinus* found by Experience. During the time of the Increase of the *Nile*, the Clouds pass over *Egypt*, driven by the Northerly Winds, and no doubt fall down in the Mountains, and contribute to moisten and cool the Air. *Prosper Alpinus* gives credit to the Experiment of judging of the Increase of the *Nile*, by a Lump of Earth taken out of the River, and kept dry, which begins to increase in Weight as the River begins to swell; and by the Quantity of this Increase, they judge of the Quantity of the Inundation. That the Earth will increase by Moisture is certain; that the Quantity of Moisture may be a Measure for that of the Rain, and that for the Quantity of the Inundation, are all probable; but a Sponge perhaps might be a better Hygrometer than the Earth of the River.

VI. There

VI. There are several Things remarkable in the Constitution of the *Egyptian* Air. The Perspiration of the Soil, which is sandy and barren, cannot affect the Air very much, the Exhalations being mostly either from the Surface of the Inundation, or the Mud and Slime after it is over. The natural Heat and Driness of the Air, and the Change from that to cooler Moisture; the Abatement of the Tropical Heats by Northerly Winds; the Extremity of Heat and Drought, by the Southerly Winds blowing over Sands; and the Moisture again induced by the Clouds, from the *Mediterranean* and the Inundation; the Exhalations from stagnating and putrid Water, when the Inundation is quite over; and lastly, the Temperance and regular Diet of most of the Inhabitants, must give a fair Experiment of the Effects of Air upon Human Constitutions. Accordingly, those who labour, live hard, and cannot defend themselves from the Injuries of the Wind, mostly dry and hot, are extremely lean and squalid: The Rich, by a plentiful and nourishing Diet, and preserving themselves from the Heat and Drought by Bathing, Relaxation of their Fibres by

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drinking

drinking the Water of the *Nile*, are often fat.

VII. The Air of *Egypt* having no noxious Qualities from the Perspiration of the Ground, were it not from the accidental ones above-mention'd, would be extremely wholsom; and the People who know how to defend themselves from those Accidents, live to great Ages. The frequent Changes of Heat and Cold, Moisture and Drought, produce all the Distempers of the Catarrhus Kind, Arthritick Diseases; and, by the strong Perspiration, Leprosies, even the *Elephantiasis*. The Effects of a hot dry Air, by a Southerly Wind, blowing over a sandy Country, are felt strongly; inflammatory Distempers, especially a raging Fever with a Phrensy, call'd *Demencia*, mortal in a few Hours. They feel likewise all the good Effects of the Abatement of this Heat and Drought by Northerly Winds, the Overflowing of the *Nile*. They are likewise subject to all the Diseases from putrid and stagnating Water, and Exhalations from Heat after the Inundation is over; and these are often pestilential; therefore such as can, live remote from the Channel of the River.

VIII. Pestilence



VIII. Pestilential Distempers are frequent in *Egypt*: It is a popular Opinion there, that they are brought from *Syria*, *Barbary*, and *Constantinople*. All I can infer from hence is, that the Plague has something infamous as well as terrible, and no Country will own it to be their own Product, for the People of *Constantinople* alledge it is imported to them from *Egypt*: But what I think demonstrates the Plague to be endemial to *Egypt*, is its regular Invasion and going off at certain Seasons; beginning about *September*, the time of Subsidence of the *Nile*, and ending in *June*, the time of the Inundation; in the first Case are all the Causes productive of Putrefaction, Heat, and putrid Exhalations, and no Winter Frost to check them. But what is wonderful, the Plague and the Fevers, from the Heat of the *Campsin*, go off by the Northerly Winds, and the Overflowing of the *Nile*. The wholesome Quality of Northerly Winds for checking pestilential Distempers, has been observ'd by all ancient Physicians; and, to shew that the Plague depends upon the Temperature of the Air, *Prosper Alpinus* takes notice, that upon the Swelling of the *Nile*, the Infection, and even the Danger from infected Clothes

and Furniture, goes off; besides the cooling of the Air, the Northerly Winds may dissipate the stagnating Vapours, and the Running of the *Nile* the stagnating Water. *Galen* and *Hippocrates* both observ'd, that the *Elysian* or Northerly Winds blowing in Summer, made a wholsom Season. This Observation is more sensible in hot Countries than in ours.

IX. I thought it worth while to inquire into the Effects of the Air within the Tropick, and particularly in some Place under the Line: It happens luckily that *Boutius*, a very learned and sagacious Physician, has left us a Description of the Air and Diseases of the Inhabitants of *Java*: Tho' its Situation under the Line must make it hot, and as therefore some would imagine extremely dry, *Boutius* says it is moist, from the great Quantities of Rain and stagnant Water, and from Moisture and Heat, and perhaps from Salts produc'd from those Qualities. The putrifying Quality of the Air is very manifest in rotting of Clothes, and rusting of Metals: From these Qualities, the Air feels to Human Bodies, piercing and active. All the Inhabitants of hot Countries have that Sensation of the penetrating

trating Quality of Air, cold after great Heats, which perhaps proceeds chiefly from the Pores of their Skin, being relax'd before by Heat; such Bodies must imbibe the outward Air faster. In *Java*, as in *Egypt*, the Northerly Winds render the Air wholesom, by abating the extreme Heat; some Land Winds carrying along with them the stagnant Vapours, are often otherwise. The Soil being fruitful and rich, emits Steams, consisting of volatile and active Parts, which fructify the Soil, but are hurtful to Human Bodies. The Seasons here cannot be distinguish'd by their Heat, by reason of the Smallness of their Latitude: There are only two; what may be call'd Winter, is the Rainy Season: This Season is attended with Diseases which depend upon Putrefaction. The Inhabitants measure their Seasons of Heat and Cold by the Times of the Day; the Mornings and Nights are cooler by the Absence of the Sun, and by the Sea Breezes; the scorching Heat of the middle of the Day, makes that time unfit for Business.

X. The popular Diseases here are,  
1<sup>st</sup>. A Species of Palsy, call'd by the Inhabitants of this and some other Countries of the *East-Indies*, *Beriberium*; the  
Cause

Cause of which is evidently cold Air, imbib'd by the Pores of the Skin, extremely relax'd by Heat before, and therefore invades such as incautiously expose themselves to the Morning Air, or throw their Bed-clothes off in the Night. Another nervous Disease, call'd *Catalepsis*, is likewise popular in this Country, and proceeds from the penetrating Quality of the Air imbib'd by relax'd Bodies. In this Disease the Patient grows rigid, like a Statue, and dies in a few Hours. Diarrhœas and Dysenteries are common from the same Cause, from sudden Suppressions of Perspiration; the plentiful Use of cold Fruits, from the same Causes; they invade us in *Autumn*. It is Matter of Observation, that great Heats exalt the Bile, perhaps by the Exhaustion of the watery Particles which dilute it by a strong sensible Perspiration; and therefore the *Cholera Morbus*, and other Diseases of the Liver, are common and fatal in the *East-Indies*; and from diseased Livers, Dropsies are common in *Java*. Atrophies are likewise frequent in *Java*. In this Country then, Fevers are seldom intermitting, but continual, with Phrensies, and other dreadful Symptoms, as during the *Campsin* in *Egypt*, proving mortal in a short time.

time. The Author describes a Species of Fever in the Islands of *Solor* and *Tymon*, with very particular Symptoms; if the Fever intermits, the Patient is seiz'd with Convulsions resembling a *Chorea sancti viti*; the Inhabitants ascribe this Disease to the Exhalations of the Santalum Tree. There are likewise Spittings of Blood, and Ulcers in the Lungs, in such as expose themselves to the Night Air. The Author takes notice of Blindness as being common in the Coasts of *Amboyna*, and the *Molucca* Islands, which the Inhabitants ascribe to the immoderate Use of hot Rice; therefore they expose their Rice, after it is boil'd, to the cool Air; perhaps they may be mistaken likewise as to the Cause of this.

XI. The Diseases of *Fort St. George*, tho' it lies in 14 Degrees of Northern Latitude, resemble very much those above describ'd in *Java*: When the Wind blows from the Westerly Points, from *April* to the End of *July*, it renders the Air so hot and dry, that were it not for Sea-Breezes from the South-East in the Afternoons, the Inhabitants could not bear it: The Effects of this Heat are a dense thick Blood, inflammatory Diseases, Fevers with Phrenies, *Cholera Morbus*,

*bus*, *Beriberium*, the *Barbiers*, as the Inhabitants call it here, the same, and depending upon the same Cause as that in *Java*. From the Middle of *October* to the Beginning or Middle of *December*, the Wind blows commonly between the North and East, and is call'd their *Monsoon*, or Rainy Season: The most remarkable Diseases of that Season, are obstinate *Diarrhœas*, from the Moisture and Coolness of the Air; and I believe it will be found an Observation generally true, That a wet Season produceth *Catarrhs* or *Serosities* of all kinds, likewise putrid Fevers, and intermitting Fevers; for during the extreme Heats, the Fevers are continual. The Air is temperate from *December* to *March*. The acute Diseases which invade in that Season, especially the *Small-pox*, are less dangerous than those which invade in a hotter.

XII. The Effects of Air extremely cold, you will find in the Journals of such as have navigated in great Northern Latitudes, or have wintered in *Greenland* and other Countries; these are taken notice of N<sup>o</sup> XVI. of the Third Chapter, and must needs be very different, and destroy Mankind by another Class of Symptoms, than those of hot Air.

## *Effects of Air on Human Bodies.*

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Air. What *Joseph D'Acosta* says of the Coldness of one Mountain of *Peru*, seems to make it exceed even that of *Greenland* in Winter, its fatal Effect upon Human Bodies being more sudden. By a few Observations collected in this Chapter, the Reader may easily perceive, that upon a general Notion of the Weather and Diseases of different Countries, a Piece of Knowledge, almost scientific, might be founded, not incurious or useless to Mankind.

XIII. There are some few modern Physicians who have left us Observations of the Seasons, and the cotemporary epidemical Diseases, as *Bernardini Ramazini*, a Physician of *Modena*, who has distinguish'd himself by several ingenious Pieces which he has publish'd in his *History of the Constitutions of the Years 1690, 1691, 1692, 1693, 1694*, and the epidemical Diseases about *Modena*, and the adjacent Countries. There are many things remarkable in the Year 1690. After four or five Years preceeding of great Drought, attended with great Plenty. There began to fall in the Spring, 1689, great Rains, upon which ensued a most destructive Miledew upon the Corn and Legumes; the Rains still increas'd, and continued the Year

Year 1690, with this destructive Plague amongst the Vegetables, which *Ramazzini* observes to be often succeeded with epidemical Diseases amongst Mankind : The whole Year was cold, cloudy, rainy, attended with a great Inundation of the *Po*, and other Rivers, the Country being all cover'd over with Water. What was observable was, the Silence of the Grasshoppers, and Croaking of Frogs, and Bees not making Honey : No remarkable Diseases in the Winter, because the Heat had not begun to raise the Vapours : A great Run of Intermitting Fevers in the Spring, which still multiply'd, and ended in double Tertians in the Summer, which were the most epidemical that ever were known, and the Country more unhealthy than the Towns ; an unusual Vermination, or Quantity of Worms in Human Bodies ; Parotids, suppurating Diarrhœas, and all other Catarrhus Distempers. These Fevers not very mortal, considering the vast Numbers that were seiz'd, except amongst Children and tender Women : No continued Fevers : Other Animals sickly ; Cattle, with Eruptions about their Heads. What was still most remarkable, was the nocturnal Accession of the Fevers, being the worst, and a  
great



great Relaxation or Debility of Patients till the Sun was up, the Fever depending upon Acidity rather than Bile; and for that Reason the Bark was generally ineffectual, and the copious Use of Wine generally beneficial. *Ramazini* assigns probable Causes for all those Symptoms: The unusual Vermination caus'd by Indigestion of the Eggs of Insects, which are commonly taken in with Aliment; Sucklings dying, from the Acidity and other bad Qualities of the Nurses Milk. He reckons the Silence of Grasshoppers a Presage of a sickly Time; and quotes *Mercurialis*, who observ'd the same thing at *Padua*, in 1577. The 1691 was directly contrary in its Temperament to the preceeding; a frosty dry Winter, a hot dry Spring, a hot Summer; and as the Seasons, so were the Symptoms of Diseases almost opposite: The popular Diseases of the Winter, were Apoplexies, Quinsseys, Pleurisies, Inflammations of the Lungs, Catarrhs, all with fizy Blood; letting of Blood, and whatever gave Fluxility to it, reliev'd. The Country-people who us'd Labour and Exercise, were more healthy than Citizens. In cold dry Weather, the Inhabitants of the Country and Cities are equally free from the noxious Qualities  
of

of the Perspiration of the Earth ; therefore the Advantage as to the other Qualities of the Air, is on the Country's Side, especially in Distempers inflammatory, because of the less Exercise, more plentiful and less simple Diet of Citizens. In the Spring, scabious Irruptions upon the Skin were epidemical ; this perhaps from the Acidity of the Blood, contracted the former Year, and the Salts retain'd beginning now to perspire by Heat. Madness amongst the Dogs was epidemical from great Heat and Drought. A prodigious Number of Fevers of the bilious kind in the Summer, which turn'd mortal in the *Autumn* ; the Remedies of which were directly opposite to those of the Fevers of the preceding Year ; for these wanted Cordials, and as it were a Spur ; but those of the Year 1691 wanted a Bridle, and were generally reliev'd by Blood-letting, cooling acid Medicines, all the Symptoms proceeding from a bilious Acrimony : The Bark, which had been ineffectual in the Intermittents of the former Year, was successful in this. *Ramazini* observes in the succeeding Years 1692, 1693, 1694, tho' dissimilar in their Temperature, yet were not very unlike in their epidemical Diseases, but

but especially in a petechial or spotted Fever, which raged most at the New and Full Moon; he ascribes this to an unusual Duration of Southerly Winds, which has been observed by all Physicians to make an unwholsom Constitution of Air; he ascribes it to this Cause, because the Inhabitants of the Foot of the *Appennines* being defended from the Southerly Winds, were not infested with these petechial Fevers. I think I may venture to add one Reflexion to those of the judicious Author, That if the great Rains and Moisture of the Year 1690, had been succeeded with great Heat, the Fevers would have put on another Genius, and perhaps been Pestilential.

XIV. There is also publish'd the Epidemical History of *Germany*, by several eminent Physicians, in which the Reader will find many things remarkable, which it would be too tedious to insert, but from which we shall draw some Observations in the last Chapter. Our learned President, Sir *Hans Sloan*, has given us a Journal of the Weather of *Jamaica*, and the History of the popular Diseases of that Country; the Resemblance of the Constitution and Diet of the Inhabitants to those of

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their

their Mother-Country, occasion a great Affinity likewise in the popular Diseases, except in some few Cases which are the Product of a warmer Climate. But as there is still a great Penury of such Observations, all we can do is to reason from the Laws of Mechanicks, and the known Properties and Qualities of Air, what must be their natural Effects. It seems agreeable to Reason and Experience, that the Air operates sensibly in forming the Constitutions of Mankind, the Specialities of Features, Complexion, Temper, and consequently the Manners of Mankind, which are found to vary much in different Countries and Climates. As to Features, what an infinite Variety ariseth from the Combination of the Parts of a Human Face, so that since the Creation of the World, perhaps there were never two that, upon a narrow Inspection, perfectly resembled one another. There are Faces not only individual, but genilitious and national; *European, Asiatick, Chinese, African, Grecian* Faces, are characteris'd. This Diversity of National Features and Shapes is not altogether the Effect of Propagation from the same original Stock; for it is known by Experience, that Transplantation  
changeth

changeth the Stature and outward Shape, both of Plants and Animals. *Hippocrates* makes great Account of the Influence of the Air upon the *Fœtus*, both before and after Birth: He is of Opinion, that the great Variety of *European* Faces is owing to that of the Air and Seasons; there being such great Excursions in the Extremities of Heat and Cold, their Offspring is as it were begot and brought forth in different Climates. That the Shape of Animals should be modify'd by the Air, is no ways unaccountable: An Animal growing, expands its Fibres in the Air as a Fluid, which, by a gentle Pressure, resists the Motion of the Heart in the Expansion and Elongation of the Fibres; and tho' the Fibres of several Animals, shoot, as it were, in this Fluid, according to their original Shapes, yet such a Fluid resisting by its Pressure, is, in respect to the Animal, like a soft Mold, in which the Body is form'd; and therefore, according to the Quantity of its Pressure, depending upon its most permanent State of dense, rare, hot, cold, dry, moist, must have some Influence in forming the outward Figure of such a Body in a State of Accretion: Besides this outward Pressure, the Air

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being

being mix'd with the animal Fluids, determines their Condition as to Rarity, Density, Viscosity, Tenuity, and several other Qualities.

XVI. That the Complexion depends much upon the Air, is plain from Experience; the Complexion of the Inhabitants of several Countries being fair, swarthy, black and adust, according to the Degrees of Heat, Drought, Moisture, or Coolness of the Air. The Inhabitants of Countries in great Latitudes are generally fairer than those that live nearer the Sun.

XVII. That the Temper and Passions are influenc'd by the Air, is no less certain: People of delicate Nerves and moveable Spirits are often joyful, fullen, sprightly, dejected, hopeful, despairing, according to the Weather; and these Changes happen, but pass unobserv'd in stronger Constitutions. There are Days in which the intellectual Faculties of Memory, Imagination, Judgment, are more vigorous, therefore it seems probable that the Genius of Nations depends upon that of their Air. Arts and Sciences have hardly ever appeared in very great or very small Latitudes: The Inhabitants of some Countries succeed best in those Arts which  
require

require Industry and great Application of Mind : Others in such as require Imagination ; from hence some Countries produce better Mathematicians, Philosophers, and Mechanicks ; others better Painters, Statuaries, Architects, and Poets, which, besides the Rules of Art, demand Imagination. It seems to me, that Labour is more tolerable to the Inhabitants of colder Climates, and Liveliness of Imagination to those of hot.

XVIII. There are two things common to all Mankind, Air and Aliment ; both indeed differ very much in their Qualities, in different Countries and Climates ; but those of the Air are perhaps more different than those of the Aliment. In perusing the Accounts of the Temper and Genius of the Inhabitants of different Countries, we discover in them a great Uniformity, even tho' the Race has been chang'd. The Temper of the *Gauls*, describ'd by *Cæsar* and other Writers, is much the same with that of the present *French* : There is a remarkable Instance of this in the *Misopogon* of the Emperor *Julian* ; if I rightly remember, he tells us that he had pass'd a Winter at *Paris*, where there were more Comedians, Dancers,

and Fiddlers, than there were Citizens besides; and I believe if a Race of *Laplanders* were transplanted thither, in a few Years they would be found in the Condition describ'd by the Emperor *Julian*. How is the rugged Temper of the Northern Nation mellow'd by the softer Air of the Countries which they conquer'd? Governments stamp the Manners, but cannot change the Genius and Temper of the Inhabitants; and as far as they are unrestrain'd by Laws, their Passions, and consequently their National Virtues and Vices will bear some Conformity with the Temperature of the Air. The Inhabitants of *Cio* are describ'd by the ancient *Greeks* as loose and dissolute, and voluptuous, and so they are at present; some modern Travellers affirm, that there is a Softness in their Air that disposeth to a sort of Indolence and Mirth. Nations, as well as Individuals, have their Constitutional Vices; and I think there is no stronger Proof of the Force of Christian Morality, than the Reformation it produc'd in National Vices in primitive Times, when it was believ'd and practis'd in its Perfection.

XIX. If we consider the Causes assign'd by *Hippocrates*, of the different Temper



Temper of the Inhabitants of different Climates, we shall find them sufficiently proportion'd to their Effects. In Northern Countries, where the Alterations of the Height of the Barometer, and consequently of the Weight of the Air, are frequent and great, the Fibres of Human Bodies are in a continual oscillatory Motion, from a Pressure of 1200, 1800, yea 3600 more at one time than another; and tho' this, by the Softness and Rarity of the Fluid, is insensible, and not dolorifick, it is a sort of Exercise which the Inhabitants of Countries, where the Variation of the Height of the *Mercury* is small or nothing, do not feel. By the Difference of the Tension of the Fibres, the whole nervous System, and the animal Spirits, are in some measure affected. Let us again consider the Extremes of Heat and Cold in great Latitudes, operating after the same manner, relaxing and constringing the Fibers by turns, and the extreme Cold acting likewise as a *Stimulus*, in consequence of which we find an Activity and Tolerance of Motion and Labour, in dry frosty Weather, more than in hot; whereas the People within the Tropicks are constantly in the State of our hottest Weather. Whoever considers

Mankind in such different Circumstances, will find that the Temper, both of their Body and Mind, must be different, and that a greater Variety in the oscillatory Motion of the Fibres of Northern People must produce the same in their Spirits, and therefore a proportional Inequality in their Passions, and consequently greater Activity and Courage. That the Inhabitants of Climates, where the Difference of the Weight, Heat, and Cold of the Air is but small, feel only the Changes of the Tension of their Fibres, proceeding from Drought and Moisture, being free from the Agitations and uneasy Sensations of Northern People, proceeding from the Causes above enumerated; and the Motions of their Fibres and Spirits being more uniform, they may be for that Reason, and from excessive Heats, lazy and indolent: From Inactivity and Indolence there will follow naturally a slavish Disposition, or an Aversion to contend with such as have got the Mastery of them. *Hippocrates* tells us, that the *Europeans* owe their Courage to the Variety and Coldness of their Climate, and their Laws which secure their Property to their Courage. Thus far I have ventur'd to explain the Philosophy of this  
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sagacious old Man, by mechanical Causes arising from the Properties and Qualities of the Air ; to which I shall add another, somewhat foreign to my Subject : That in Countries which do not produce without much Labour, the Land-holder must have Assurance of the Necessaries for his Culture, as his Seed, Granary, domicile Working-tools, &c. This must create some Property, and where there is Property, there must be Laws to secure it : From which I beg leave to draw one Corollary ; That despotick Governments, tho' destructive of Mankind in general, are most improper in cold Climates ; for where great Labour is necessary, the Workman ought to have a certain Title to the Fruits of it. There are Degrees of Slavery, and, generally speaking, it is most extreme in some hot and fruitful Countries.

XX. I will venture to add another Observation, which, tho' it may seem a little too much refin'd, is not improbable : That the Air has an Influence in forming the Languages of Mankind : The serrated close way of Speaking of Northern Nations, may be owing to their Reluctance to open their Mouth wide in cold Air, which must make their Language abound in Consonants ;  
whereas

whereas from a contrary Cause, the Inhabitants of warmer Climates opening their Mouths, must form a softer Language, abounding in Vowels. Another Observation is, That People in windy Countries naturally speak loud, to make themselves be heard in the open Air.

XXI. That the Constitutions of Mankind differ according to the Qualities of the Air in which they live, is an uncontested Matter of Fact, and depends upon obvious Causes. *Hippocrates* observ'd, That the Inhabitants of moist Countries were bloated, leucophlegmatick, and dull, from the Relaxation of their Fibres, and the Moisture imbib'd with the Air; and contrary Causes must produce contrary Effects: Heat indeed relaxeth the Fibres, but by absorbing the Moisture may likewise harden, and render them more solid. The Bones of Animals in hot Countries are more solid, and specifically heavier, than of those in cold Climates, as may be seen in comparing the Bones of the Limbs of *African* Horses, and those of Northern Countries. The Blood too, in hot Countries, is thicker and blacker by the Dissipation of the serous Part, by sensible Perspiration: This is Matter of Fact,  
attested

attested by Physicians who have practised in those hot Countries. From this black adust State of their Blood, they are atrabilarious. Great Heats exalt the Bile, by dissipating the Moisture which dilutes it. Bile, of itself, is the most unperpirable of Animal Fluids ; it stops at the Surface of the Skin, and discolours it. The Animal Juices, in hot Countries, are more exalted ; this is true in venomous Creatures. There is some Analogy between Plants and Animals, and both are longer in coming to Maturity in cold and moist Air. The prolifick Age of Mankind is much earlier in hot than cold Countries, the Females being in that State at Ten Years of Age. The Inhabitants of warm Countries are not subject to be fat, for a strong Perspiration keeps an Animal from being so. A copious Diet and Inactivity will always occasion Exceptions from the general Rule.

XXII. Cold and moist Air must necessarily produce phlegmatick and lax Constitutions, and by stopping Perspiration with a copious Diet, accumulate the Animal Oil. Dry and cold Air in a Degree tolerable to Human Bodies, which is the State of our Winter Frosts, creates a strict Constitution of the Fibres,

bres, and all the Effects thereon depending, Vigour and Activity.

XXIII. As to different Heights and Regions of the Air, it seems probable that the Constitutions of Miners and Mountaineers must differ considerably; and I wish the Differences were well observ'd. Mountaineers, by having a less Pressure of Air upon them, must exert a greater Degree of Muscular Strength, like Birds who move in a rarer Element, and by steep Ascents and Descents a greater Variety and Force in progressive Motion. The Coldness of their Air in some measure balanceth the deficient Pressure by Weight. These Causes naturally produce Strength and Activity; and even the Pride and Ferocity ascrib'd to them by *Hippocrates*. As Air has a great Influence upon the Fluids and Solids of Human Bodies, it will stamp and form them according to its most permanent State, during the Cycle or Period of the Season in that Region of the Earth. But leaving this Matter to be further pursued when there are more *Data* from Natural History to proceed upon, I shall make a few Observations upon the Qualities of the Air, as far as they are Nosopoetick, that is, have a Power of producing Diseases.

XXIV. Popular

XXIV. Popular Diseases depend upon what is common to all the People; these are chiefly Air and Aliment; it is easy to distinguish the Effects of both. The genuine Effects of Air in producing Diseases is best discover'd in People who live on wholsom Aliment, and are temperate.

XXV. Acute popular Diseases are commonly the Effects of the Temperature of the Air; they often invade at stated Seasons of the Year; their Riseness, Duration, different Symptoms and Periods, seem to depend upon the Alterations of the Weather, and the State of the Air preceding and consequent upon these Alterations. I think this may be inferr'd from the great Uniformity that is observ'd in the Symptoms of the Epidemical Diseases of the same Season. I believe no body doubts that the late Distemper which affected all *Europe*, was the pure and genuine Effect of the State of the Air. A Person in perfect Health going into a Place infected with an epidemical Disease, shall be seized with it without any other Error in his Diet, and even without Suspicion of Infection.

XXVI. As the Force of Human Bodies is limited, they are not capable to  
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bear Extremities of any kind, of too great Rarity, Density, Heat, Cold, Moisture, Drought in the Air. From the same Cause Human Bodies do not easily sustain violent and sudden Changes which agitate the Fluids and Solids too much; for as the State of our Fluids and Solids change with the Air, violent Alterations in the latter produce the same in the former; therefore variable Weather is commonly productive of Diseases; for Example: Suppose such a State of the Air as maketh a great Stricture of all the external Parts of the Body, and consequently an Abatement of the Circulation in the Vessels exposed to the Air, and in those which immediately communicate with them: Suppose again the Air is suddenly chang'd from this State to one which violently relaxeth the Fibres, by their Relaxation, it is possible that the Vessels which were destin'd before to carry the Serum, or Lymph, may admit the Blood, which is an inflammatory State: Accordingly we find that inflammatory Distempers of several kinds are rise in moist and warm Weather, preceded by hard and lasting Frosts: Frost stops the Perspiration of the Earth, which being restor'd by Thaw, fills the Air with an unusual  
Quantity



## *Effects of Air on Human Bodies.*

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Quantity of Vapours, which affect Human Bodies, not only by Relaxation, but as they imbibe them with the Air.

XXVII. The Weather and Diseases of Countries have a good deal of Uniformity ; but the unusual Excesses of Heat, Cold, Moisture, and Drought, produce either a greater Plenty, or unusual Symptoms in Diseases ; and operate more strongly, if the Alterations are sudden and extreme.

XXVIII. By the Doctrine and Observations of Chap. III. it is plain that Human Bodies cannot long sustain Heat approaching to their natural Heat, far less that exceeding it. An Animal dies of an Inflammatory Distemper with all the Symptoms of Putrefaction in a Sugar-Baker's Drying-Room. There are some Countries in which, during their greatest Heats, Wax will melt ; Mankind, without some Defences by Art, cannot bear such an Air. The Symptoms which one feels in extremely hot Weather are feverish, a Pulse quicker than natural, profuse Sweats, great Thirst, Debility, Dejection of Appetite ; by great Sweats the Blood is render'd dense ; by Debility the Force of the Heart itself is diminish'd ; and indeed by the Continuance of the Heat, the whole Body in  
time

time may be render'd dry and squalid ; add to this, sudden Refrigeration by cool Air, so desirable to Mankind in such a State, for the sake of which they often incautiously expose themselves : I say it is very accountable how such a Constitution of the Air may work as a *Stimulus*, and produce dangerous continued Fevers ; and that Catarrhs, and Diseases depending upon Defluxions of Serosity upon any Part of the Body, in Coughs, Rheumatisms, Gouts, Diarrhœas, should in such a Constitution much abound, both by Suppression of Perspiration, and by a sudden Admission, imbibing of this Serosity by all the Pores of the Skin, of cool Air, and then he may undergo all those Symptoms in a greater Degree ; accordingly, hot Days, with cool Nights, are commonly productive of Diarrhœas, such is our Weather in the *Autumn*.

XXIX. Heat, (as was observ'd Numb. XIX. of this Chapter) naturally exalts the Bile ; therefore bilious Fevers, and *Cholera Morbus*, may be the natural Product of such a hot Constitution of Air.

XXX. Cold both congeals the Fluids and constringeth the Solids. It acts like a small Ligature upon the Vessels, by which the Circulation through the Vessels

sels is retarded; the natural Effect of which is a greater Secretion of Scrofula through the Glands contiguous, for the Extremities of the Vessels near the Glands being press'd, they cannot so plentifully carry off the reflux Fluid, by which there must be a greater Flux of Liquor towards the Glands, and a greater consequently from its Emunctories; therefore Catarrhs, or serous Defluxions upon all the Parts of the Body, but especially from the Glands of the Head and Throat, are a natural Effect of Cold.

XXXI. Obstructions by Cold in the outward Parts of the Body, drive the Blood pressing with a greater Force upon the inward Parts, and increase Heat. Sisy Blood may be another Effect of Cold; this is extremely well illustrated by the ingenious Dr. *Thomas Simson Chandos*, Professor of Physick in the University of St. *Andrew*, who has explain'd the Effects of Cold upon the Humours very clearly, by a plain Experiment shewing that Blood, after a strong Ligature upon any Joint, will be sisy upon the letting it out of the Vein with a free Stream; and the Professor reasons very justly, if the white Chyle is made red by the Force of  
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Motion, by the Retardation of this Circulation, in some Parts the Blood may grow white, and crude again: Cold is a small sort of Ligature upon the Vessel affected with it, constringing the Vessel.

XXXII. It was observ'd, N<sup>o</sup> XXII. Chap. III. That these Qualities of the Air act either by the Sums or their Differences, as they conspire in the same Effect, or act oppositely. Thus Heat and Moisture both relax; but if the Air is cold with Moisture, in that Case the Vessels may be constringed, and such a Constitution may produce all the Effects of Cold. Water relaxeth all Fibres, Vegetable and Animal; yet a cold Bath constringeth the Fibres for a while; any moist Steam relaxeth in Proportion to its Heat; besides, Water may obstruct as well as relax.

XXXIII. The more pliant the Vessels are, as in tender and young People, they are more sensible of Impressions by the outward Air; they have a greater Play in the Degrees of Tension than the Vessels of old People; therefore the Qualities of the Air in constringing and relaxing the Fibres produce greater Effects upon them; the longer Animal Fibres are kept in any State,

State, the more they lose their Power of restoring themselves: Therefore the most permanent State of the Air of any Country may produce endemial chronical Diseases.

XXXIV. Cold is capable of producing all the Diseases which depend upon too great a Stricture of the Fibres, and by diminishing the Quantity of Perspiration, either increaseth that of the other Secretions, or produceth a greater Fullness and inward Heat. The Summer Perspiration being near double of that of Winter, the Appetite, and consequently the Aliment, not diminish'd, may induce all the Symptoms of a Plethora, if the other Secretions are not proportionally increas'd.

XXXV. Cold by suppressing the Perspiration of Salts in the Blood, by congealing the Blood, and likewise by a dolorifick *Stimulus* corroding the Skin, is apt to produce Scurvies and other cutaneous Irruptions, and in Extremity is capable of freezing the Fluids, and reducing Animal Substances to a gangrenous State.

XXXVI. Cold Air is capable of making inflammatory Distempers with cutaneous Irruptions more dangerous, by hindering the Relaxation of the Skin.

I believe it will be found that the Small-pox is most fatal during hard Frosts, and cold North-Easterly Winds. I remember that the Small-pox which were exceeding mortal during such a Season, grew more favourable by the Tepor and Moisture in *April* and *May*. The artificial Qualities produc'd in the Air of the Patient's Room, are not sufficient to balance its natural State.

XXXVII. Cold Air, by its immediate Contact with the Surface of the Lungs, is capable of abating or stopping the Circulation of the Blood, and bringing them into an inflammatory State, and by producing Catarrhs and Coughs, is productive of all the Effects of such Defluxions upon the Lungs, Ulcerations, and all sorts of pulmonick Consumptions.

XXXVIII. As to Moisture and Drought, the Excesses of them most necessarily bring Human Bodies into a morbid State, because they are incapable of bearing these Extremes. There is a certain Degree of Humidity necessary to relax the outward Parts of the Body, to preserve the Pores of the Skin in their due Symmetry; the same due Degree of Humidity is perhaps necessary to be absorb'd with the Air, by the Pores of the Skin.

XXXIX. Long

XXXIX. Long Droughts have been found most dangerous of all to Human Bodies. The Year 1708, the coldest Winter that perhaps was ever felt in *England*, was not attended with any great Mortality amongst Mankind. The Year following, 1709, was the wettest that was ever known, there having fall'n about  $26\frac{1}{2}$  Inches of Rain in *Essex*, yet there were no extraordinary Diseases nor Mortality that Year; the Year succeeding, indeed the Small-pox were rife and mortal. The Year 1714 was the driest Year that has been yet observ'd, there having fall'n that Year in *Essex* not much above 11 Inches of Rain; so that the Difference as to Moisture, between 1709 and 1714, was above Half, and their Proportion as 53 to 24; the Bills of Mortality in *London*, in 1714, increas'd 5512, and the Mortality begun that Year amongst the Cattle. There has been an unusual Drought for these two Years past, for I think the best Estimation of the Drieness of the Surface of the Earth, must be taken from the falling of the Springs, the Consequence of which has been unusual Diseases amongst several Animals, and a great Mortality amongst Mankind. It is true, this did not happen during

the dry Weather ; the sudden Alteration, as well as the preceding State, might operate, the Surface of the Earth being by the Drought first shut up, and afterwards opened by the Rain, might affect Human Bodies variously, as in warm Weather, and Thaws after great Frosts.

XL. Moisture relaxeth, unless it be combin'd with a greater Degree of Cold, which subducts so much of its relaxing Quality. The Inhabitants of cold and moist Countries are leucophlegmatick, bloated, and have all the Symptoms of Relaxation ; therefore Effects of such a State of Air are all the Diseases which the Methodists class under the Title of the *Laxum*. If Air is imbib'd by Human Bodies, the watery Parts, and perhaps these chiefly, enter ; and catarrhus Distempers seem to depend upon the Moisture, as well as the Coldness of the Air. The least Moisture taken in by the Windpipe, immediately is rejected by Coughing. It is not merely the Suppression of Perspiration by Cold or Moisture, that is the Cause of the Coughs and Defluxions upon the Breast, by inducing a Plethora, and a proportional one in the Glands ; but the moist Air is really imbib'd, and affects the Glands by  
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immediate Contact, or as a *Stimulus*. It appears by the Journals of Perspiration, that Coughs and Colds have often invaded, where there was no Suppression of Perspiration, and that a Suppression of Perspiration is not always attended with a Cough or a Cold. Moisture imbib'd with the Air, after Relaxation of the Pores of the Skin, may affect all the glandulous Parts of the Body, even those of the Guts, producing Diarrhœas. I know it to be true by Experience, that moist Air is productive of nephritick Colics, in such as are subject to them. However, I propose this as a Probability, which by future Observations and Experiments may be better cleared.

XLI. Hot and moist Air producing Relaxations, and consequently an Abatement of the Force of the Solids in propelling the Fluids must produce Stagnation, Tumors, and Putrefaction in the Liquids, and all the other Diseases depending upon a lax State of Fibres: *Hippocrates* observ'd such Diseases always consequent upon a moist Constitution of Air, with Southerly Winds, which are warm; and I have observ'd the same in this Country. As Perspiration is the last Action of perfect Animal

Digestion, that Constitution of Air which suppresseth Perspiration must hinder Digestion; therefore cold and moist Air must be hurtful to Stomachicks. Catarrhs and Coughs are the Effect of cold and moist Air, and those habitually affecting the Lungs may produce pulmonick Consumptions; yet it seems probable, that where those Consumptions are a popular Disease, they proceed from some particular Acrimony in the Air of that Country, affecting that tender Organ by immediate Contact, and perhaps all the Glands of the Body, for our Consumptions are scrophulous. Scrophulous Distempers are very common in this Country. If the Air be charg'd with any saline acid Particles, they will naturally coagulate the Fluid where they touch. From the Abundance of Mineral Waters of all sorts in *England*, it may be inferr'd, that there are abundance of Mineral Steams.

XLII. The Chirurgeons prove the Effects of Air in their Profession, even more than the Physicians; for when the Fibres of Human Bodies gape, by a Wound or Sore, the outward Air has an immediate Access to the open Vessels, and affects the Fluids in them by immediate Contact, and affects a wounded Part as  
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it were raw Flesh: The Healing of this Wound, or the Union of its Parts, is perform'd by the Elongation of the Fibres, and that depends both upon the State of the influent Fluid and its vascular Fibres, as to Flexibility, Rigidity, Strength, or Degrees of Resistance; and those depend very much upon the Air, which is in immediate Contact: For Example, A Wound in cold frosty Weather must gape more, because the Cold contracts the Fibres more than tepid Weather, therefore in the latter the Fibres must be more pliant and flexible; such a Constitution of the Air as would naturally putrify raw Flesh, must endanger by a Mortification. Defences by Emplastick Applications are not sufficient to defend a Wound or Sore from being affected with the Air which toucheth it; therefore Chirurgeons are somewhat nice in the Choice of the Seasons in which they perform certain Operations. From the Qualities of the Air it happens that Wounds in different Parts of the Body are some easier, some harder to be cur'd in different Countries. An eminent Chirurgeon of our Army, during the last War with *France*, was pleas'd to tell me two very remarkable Things relating to this Subject: One was,

was, That after the Battle of *Hochsted*, the Wounded in the Hospital of *Norlingen* in *Germany*, fell all into adematous Swellings, of which many miscarried; that after they were remov'd into another Air, this Symptom went off. Another Observation was, That at the Siege of *Lisse*, there was a great Disposition in every Wound to turn gangrenous, especially those of the Head, so that few recover'd of those that were trepan'd. This he observ'd to be peculiar either to that Season, or to that Place. In the Hospitals at *Paris*, Wounds in the Head are much dispos'd to Gangrenes.

XLIII. From what has been said on the Subject of the Effects of the Air on Human Bodies, it is plain that no vitious State, either of the Solids or Fluids, but is producible by the common Properties and Qualities of Air, and their Changes and Combinations. By the Qualities of Air the solid Parts may be stimulated: For Example, The *Stimulus* of extreme Cold is very sensible: Heat, or any Quality of Air so excessive as to produce a dolorifick Sensation, acts as a *Stimulus*: What obstructs the Passages of the Vessels which communicate with the Air, is stimulating, by increasing the Force of the Heart and the  
Fibres

Fibres to overcome the Obstruction; this either Cold or Moisture may do, which often produce, first Chilness, and then a succeeding Heat, which are feverish Symptoms; Many volatile Particles floating in the Air, as the odoriferous of Vegetables, act as a *Stimulus*, and we find can produce Headaches: That the Fibres are constringed and relaxed by the Alternations of the Properties and Qualities of the Air, we have already demonstrated: That the Fluids may be vitiated in the same manner, is no less plain: That the Blood may be condensed by Heat, by absorbing the most fluid Part: That a certain Degree of Heat will attenuate, and a greater coagulate the *Serum*; and Heat in general is capable of producing great Acrimony and putrid Fevers of all sorts, is true from Experience, and any Degree of Heat greater than that of a Human Body will do so; for our natural Heat is near the Degree of Coagulation. Cold likewise condenseth the Fluids in immediate Contact with it. Cold is capable of producing Sizeness and Viscosity in the Blood. By the same Causes, Acrimony of all sorts, to the Degree of Putrefaction, is producible by Air. Evacuations of all sorts, from all the glandulous Parts of the Body, are pro-

producible by the Stoppage of Perspiration: For Example, There is no diuretick Medicine which works so strong in a Flux of Urine, as a Suppression of perspirable Matter in Hysterical Cases. Cold promotes all Catarrhs, Coughs; and moist Air, Diarrhœas, and copious Secretions from the Glands of the Guts; without which Evacuations, Stoppage of Perspiration produceth a Plethora or Accumulation of the Humours in the Vessels. From these Considerations it appears that the Diseases, especially the acute of any Season, chiefly depend upon the Constitution of the Air, by which they are modify'd, as to their Riseness, Duration, Degrees of Danger, their particular Symptoms, Circulations and Periods: In which we must not only consider the present, but the preceding State of the Air, because, as they are more similar or contrary, the Alterations produc'd in Human Bodies, are less or more violent; particularly, I believe it will be found that sudden Changes from the Extremes of Cold and Dry to Heat and Moisture, are Causes which operate strongly in modifying the Diseases of that Season: That long and excessive Heats, by inducing Debility, are apt to stamp the succeeding Fevers with nervous Symptoms:

toms : That such a dry Constitution of Air as is apt to curb the Skin, and obstruct its Pores, makes the Crisis by Sweating more difficult ; perhaps the different Periods of Fevers, Quotidian, Tertian, Quartan, may depend upon a preceding greater Viscosity, or Obstruction in the Vessels, produc'd by the Constitution of the Air : That the more dangerous State of Small-pox, and other inflammatory cutaneous Irruptions, depends upon the Air, I think, seems very plain, as it induceth a greater Laxity or Stricture of the Fibres, or creates a greater Obstruction in the Vessels of the Skin : That Diseases of the Lungs, as far as they are not the Product of bad Diet, depend chiefly upon the Qualities of the Air, seems evident ; the Lungs are expos'd to the outward Air, which has an immediate Admission into the Air-bladders, and perhaps into the Blood-Vessels ; and whatever Effect the Air has upon the Skin, this must be expected upon the Lungs in a particular manner. It is needless to enumerate many Particulars, which the Reader may easily collect from the Chapter that treats of Respiration.

XLIV. I have hitherto consider'd only the common Properties and Qualities  
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of the Air which are sensible, and shewn that they are productive of all the Symptoms of Diseases, and for which there is no Occasion to have Recourse to its Qualities, occult or extraordinary, which probably it is often endued with : For besides the Qualities of hot, cold, moist, dry, the Air may be saline, oily, both which Qualities it discovers sometimes by its Effects on Bodies ; besides, from the Action of the heterogeneous Bodies contain'd in it, some new Substances may be produc'd of a Nature different from the Ingredients. The saline Exhalations from the Earth may be different at different times ; such Salts exhal'd at particular times from the Earth, may enter Human Bodies, and operate like Poisons, and suddenly infect the whole Mass of Blood, as the Venom of a poisonous Animal, or as other Substances injected into the Blood-Vessels, which produce immediately mortal Symptoms ; or they may operate more slowly, and produce unusual Diseases. This is not an impossible nor improbable Supposition ; yet there is no Necessity always to have Recourse to it, there being no Change in Human Bodies known, but is producible by the Contents, Properties, and Qualities, which we are sure  
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the Air is endued with, and especially by their great Enormities and sudden Successions and Alterations; to such occult Qualities in the Air, many have ascrib'd Plagues and Pestilential Distempers, upon which I shall make a few Remarks in the following Chapter.

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C H A P. VII.

*Remarks on the Pest and Pestilential Fevers, as far as they are influenc'd by the Air.*

I. **T**HAT it is very difficult to come at Truth in the History of Plagues; this is not to be wonder'd at, considering the Terror, Superstition, and Credulity of the Vulgar, and the publick Disorder during Pestilential Seasons. There never was any Plague better attended, nor better inquired into by Physicians, than the last of *Marseilles*, yet the Facts (especially those relating to its original Cause) asserted by some of the Town Physicians, are as positively deny'd by the Physicians sent down by the Regent, and perhaps upon a more exact Inquiry, and better Evidence.

II. There

II. There is something infamous as well as terrible in the Plague, so that no Nation will own it to be natural to their Country. \* The *Egyptians* affirm it is brought to them from *Barbary*, *Syria*, and *Greece*. The People again, in and about *Constantinople*, affirm as confidently, that it is brought to them from *Egypt*. As far as the Plague depends upon the Air, these Questions seem naturally to arise: Whether any Constitution of Air is capable of producing it in a Place where it was not brought by Infection? What Influence the Air has in propagating it? In a Matter both so uncertain and important, I shall hardly venture to determine positively, but lay the Evidence fairly before the Reader, and leave him to judge. And for the sake of some Readers, I think it necessary to explain some Terms of Art.

III. An Endemial Disease is what is common to the People of the Country. A Disease is Epidemical, when it affects Multitudes, at any particular Season or Time. A Sporadical Disease is an Endemial Disease, that in a particular Season affects but a few People. I shall

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\* Prosper Alpinus.

likewise beg leave to adopt another Word. An Indigenous Disease is what is natural only to one Country, and from it propagated to others by Infection: For Example, The Small-pox was perhaps a Disease indigenous to *Arabia*, and from thence propagated amongst all Mankind; but now in those Places where it has once come, it may be properly said to be Endemial or Popular, but not Indigenous; there is no need of any new Infection from its Original Country to carry it on; and it has become almost universal, missing few who live long enough to have it. This is manifestly different from the Case of the Plague; for tho' it has been at Times and great Intervals of Years in most Countries of *Europe*, and during those Seasons Epidemical, yet one can hardly call it Endemial, except in some Places of *Turkey*. Where the Plague invades and goes off regularly at stated Seasons, it is probably there both an Indigenous and Endemial Disease.

IV. The Plague seems to be a particular Disease, characteris'd with its proper Symptoms, which are nearly uniform wherever it invades, an inflammatory Distemper, with Eruptions upon the external Parts of the Body, in Buboës,

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by the Inflammation and Suppuration of the axillary, inguinal, and other Glands, or in beginning Gangrenes, by Carbuncles in some Parts, or Spots, red, livid, black, over all the Body; or lastly, in *Stigmata*, or what they call the Tokens, which are Mortifications quite compleat, the Parts being insensible.

V. The Symptoms of the Plague resemble those of other inflammatory Distempers, with Eruptions, particularly *St. Anthony's Fire*, in which, after a continued Fever of two Days, invading with a Rigor, there appears a Tumor, Discoloration, and a sort of Carbuncles upon the Skin at the same time; the axillary Glands are often inflam'd, and sometimes suppurated: This Analogy between the Plague and *St. Anthony's Fire* was observ'd by Dr. Sydenham. There is the same Analogy between the Plague and the Small-pox; the Fever invades in both Cases with the same Symptoms; Pains in the Head, Back, Vomiting, Anxiety, sparkling Eyes, high Colour in the Face, &c. This Fever after two Days produceth, in the Plague, an inflammation and Tumor in some Glands about the Head, Neck, Armpits, Groin; in the Small-pox the same in the Glands of the Skin: These Glands, in both Cases, suppurating

suppurating kindly, make what one may call a favourable Plague, or Small-pox; if those Eruptions end in Gangrenes, in either Case, it proves the Disease to be dangerous or mortal, according to the Number or Condition of them. The sudden Deaths in the Plague seem, as in the Small-pox, of such as die in the first Stage of the Disease, only the Plague more malignant. The Prognosticks both in the Plague and Small-pox depend upon the same Principles, and the Danger in both to Subjects of the same kind: As to childing Women, young vigorous People after Irregularities of Diet, in such it begins with Hæmorrhages, especially bloody Urine, such Symptoms being the Marks of the Degrees of Inflammation. Astriction of the Belly in the beginning of the Distemper is good in both Cases. Buboës increasing fast, flatulent, without the natural Inflammation and Suppuration. Buboës too hard and horny, or with a Rainbow, that is, a Mortification about them, fatal in the Plague; in short, Buboës well inflam'd, producing a laudable Matter, generally end well. These Prognosticks are analagous, and hold in the Small-pox: Nor do I mention these Things as strange, since they depend upon the

same Causes, but only to shew that the Plague seems to be an inflammatory Distemper of its own kind, like the Small-pox; the Havock made in the inward Parts by the Plague and Small-pox is much alike. What likewise proves the Plague to be a Species of Disease different from all others, is, that if we can believe the Relations of Travellers, there are Countries where it never was at all, as the *East-Indies*, *China*, the Kingdom of *Timquine*, *Cochine China*, and most Places of the *West-Indies*. Those Considerations make it probable that it is a Disease indigenous to some Tract of Ground, and from thence propagated to other Places by Contagion : And yet,

VI. As to the first Question, Whether the Air is capable of producing the Plague without Infection, in a Place where it is not an endemial Disease, I think the Affirmative is very probable; for First, In a Country where it is both an indigenous and endemial Disease, it must be probably owing to some particular Quality of the Air. Secondly, It has been prov'd by the Doctrine of the foregoing Part of this Essay, that there is hardly any Alteration, even to the utmost Degree of Putrefaction, but may be produc'd by the Enormities, Combinations,

tions, and Alternations of the common Qualities of the Air; and that still more extraordinary Effects may be produc'd by some Contagion of the Air, by uncommon Effluvia from Bodies near the Surface of the Earth. \* A Philosopher most learned in Physiology of the Air, gives Instances of Steams of a particular Nature, being emitted from the Earth at particular times; that Mines will emit Steams noxious to Vegetables at particular times; that there may be indeed some Tracts of Ground free from such Minerals as emit those noxious Effluvia, and consequently free from the Plague, as proceeding from the local Qualities of their Air; but then those Effluvia may be carried and mix'd with the Air of that Place by Winds. *Mezeray* tells us that the Plague which happen'd in *France*, in the Year 1346, the most universal and fatal that ever was known, began in the Kingdom of *Cathay*, by a Vapour most horridly foetid, that breaking out of the Earth, like a kind of subterranean Fire, consumed and devoured above 200 Leagues of that Country, even to the Trees and Stones, and infected the Air after a wonderful man-

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\* *The Honourable Mr. Boyle.*

ner; that from thence it pass'd through *Asia* into *Greece*, *Africa*, and *Europe*. The learned Philosopher above-mention'd gives Instances of the noxious Qualities, as well as abundance of some Minerals, particularly Orpiment; and of the Hurtfulness of Arsenick, worn outwardly in Amulets, producing all the Symptoms of the Plague, and which were cur'd by antipestilential and alexipharmick Remedies. There are credible Relations of Facts during the Plague of *London*, whereby it appear'd that the Air near pestiferous Houses discolour'd the Walls. There is nothing improbable in the Hypothesis of extraordinary Effluvia. Thirdly, Those Plagues which have cut off the greatest Part of Mankind, in different and distant Countries, without mutual Commerce, must have an universal Cause, and there is hardly one imaginable besides Air. There were two such Plagues in the Time of *Marc Anthony*, and one in the Year 1450. Fourthly, There has been generally observ'd something particular in the Seasons and Constitutions of the Air, preceding the Plague, as great Droughts, lasting Southerly Winds, sometimes lasting Calms; this was the Constitution always suspected by *Hippocrates* and other ancient Physicians; such was that  
that



that before the Plague of *Nimiguen* \*. Great Droughts, as has been observ'd before, have been always found noxious to Human Bodies. The Constitution previous to the Plague of *London*, was very singular, a hard winter Frost, lasting till near the End of *March*, a sudden Thaw, the Ground cover'd with Water from melted Snow and Ice, and great Heats succeeding, Mankind being as it were in a Room flooded with Water with a great Fire. In some Places it has been observ'd, that the Exacerbation of the Disease kept time with the Lunations, raging most at the New and Full Moons; that there has been in pestilential Seasons an unusual Quantity of sulphureous Vapours in the Air, Flesh, and other animal Substances putrifying sooner than ordinary, wild Birds leaving the infected Places, and tame ones dying in their Cages; all other Diseases being more rife and mortal, and, as it were, participating of the Plague. Before the Plague of *London*, Inflammations of the Lungs were rife and mortal, as were likewise the Meazles. Fifthly, What seems to demonstrate that the Disease depends upon some noxious Quali-

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\* Diemerbroeke.

ty of the Air, is not only the Suddenness of the Stroke, attended often with a Predisposition of the Body : For Example, It has been observ'd that any thing which induceth a sudden Change in the Motion or Qualities of the Blood, subjects the Person to the Infection ; in a Woman, Abortion, or Childbed, sudden Passions of Fear, Anger, &c. all Excesses and Irregularities of Diet ; young and florid Blood, rather than vapid and cachectical : All these Cases resemble a sudden Taint of the animal Fluids by Air, as some Liquors are spoil'd by a Thunder-Storm, and, by the way, seem to demonstrate, that the Contagion does not proceed from an animate Cause, for invisible Insects would bite or sting, whether a Person was in a Passion or Calm ; for here is a Concurrence of a Disposition in the Fluids with something which operates very suddenly upon them, which can hardly be suppos'd any thing besides Air, insinuating some Poison like that of a venomous Animal, and tainting the Blood when it is most agitated. Violent Exercise likewise disposeth to the Pestilential Infection, by admitting after it the Pestilential Air through the Pores of the Body. The Diet which promotes a generous Perspiration, without

out inflaming, is the best Preservative, and the Poor who are unprovided with such Aliment, and most exposed to the Air, suffer most; during a copious Perspiration, the outward Air is not so much absorb'd, and the noxious Qualities of the Air affect those who are most expos'd to it. This agrees with Experience, for the *Europeans* preserve themselves from the Plagues that rage in *Turkey*, by shutting themselves up, which perhaps operates not only as avoiding the infected People, but the tainted Air. The best Remedies in the Plague are Diaphoreticks, such as expel noxious Steams out of the Body. These Observations seem to point at the Air as the efficient Cause of the Plague; but some of them indeed do not prove more than that Air is the Medium through which the Infection is propagated. And Sixthly, It has been observ'd that there is a great Analogy between the Symptoms of the Plague and *St. Anthony's Fire*, and that they differ only as to the Degrees of the Inflammation. Therefore I believe hardly any one would venture to deny that a Constitution of Air which makes *St. Anthony's Fire* epidemical and violent in its Symptoms, heighten'd in its malignant Qualities, might possibly  
carry

carry the Eruptions upon the Skin from red to livid, from Inflammation to Mortification, and likewise the Inflammation of the axillary and inguinal Glands to large Tumors and Suppurations, in which Case it would be term'd the Plague. Dr. *Sydenham* observes, that the epidemical Fever which preceded, attended, and succeeded the Plague of *London*, was the same with the Pestilential Fever, only during the Plague it was more violent, producing those Eruptions from which the Plague is denominated. Seventhly, All the Symptoms of the Plague proceed from a high alkaline bilious Acrimony; this is evident from the Symptoms of the Disease, for one Effect is the same with the alkaline Salts, which raise an *Esfchare*; and by Experiments made during the Plague of *Marseilles*, a small Quantity of the Gall of a pestiferous Body, mix'd with Water, and injected into the Vein of a Dog, infected immediately with all the Symptoms of the Plague, the Animal who had convers'd safely before in the Hospitals of the Infected: Such a bilious Acrimony is certainly producible by Air, and by many other Causes: Besides, what demonstrates a malignant Quality of the Air in a Pestilential Season,

son, is the great Mortality of other Diseases; the whole Mortality during the Plague of *London* was 97306, the Mortality by the Plague 60506, whence the Mortality of other Diseases must have been 28710, considering the great Emptiness of the City at that time. This must needs have been above three times the common Proportion. From all these Considerations I think one may infer, that the Plague may be produc'd by some malignant Quality of the Air without any Contagion.

VII. But that the Air is the chief Instrument both of propagating and extinguishing it, I believe no Body can deny; and this must be true from what Cause soever you deduce the Plague; if from an animate Cause, as from invisible Insects, the favourable Constitution of the Air to their Propagation must be suppos'd; if from Infection of any kind, the Air is the Medium through which it is propagated, and must favour it, more or less, in different Seasons, because by the Change of the Qualities of the Air, it is quite extinguish'd, and, generally speaking, by Cold; after the Pestilential Season is over, People return to their Houses with Safety. I believe one may safely affirm, that there is hardly

ly any Year in which there are not in *London*, Fevers, with Buboes and Carbuncles; and that there are many Petechial or Spotted Fevers, is certain. What shall we call Diseases with the same Symptoms, when they seize many or few in the first Case, when it spreads and turns epidemical and infectious, we call it the Plague; and when it does not spread perhaps it is the same Disease, only sporadical; all this depends upon the Constitution of the Air.

VIII. It is no less clear that the Plague is often brought into infected Places by accident, and that it may, and necessarily must be spread by Contagion. *Marseilles*, by its Commerce with *Egypt* and *Turkey*, has been more frequently infected with the Plague than any City in *Europe*. There are upon the Records of that City, an Account of Twenty great Plagues. By the Histories of Plagues, and particularly that last of *Marseilles*, the manner of spreading of the Disease seems to be gradual, at first seizing Houses, then Streets, Quarters of the Town, and at last, like an universal Conflagration, the whole City. What was remarkable in the Plague of *Marseilles*; an open and airy Street,

well persflated, where the better sort of Inhabitants liv'd, was the last infected: This is easily accounted for from what was said in the First Chapter, about the Noxiousness and Quantity of animal Steams. 1<sup>st</sup>. Let it be consider'd to what a large Extent the Effluvia of some Bodies will infect the Air; for Example, the Snuff of a Candle: By what was said in the First Chapter, the perspirable Matter of less than 3000 Human Creatures would make an Atmosphere 71 Feet high, over an Acre of Ground, in 34 Days. This perspirable Fluid is to Air in Density, perhaps as 800 to 1; therefore if you extend the 3000 People over a hundred Acres of Ground, there will remain 8 Inches, the greatest Part remaining unblown off, and spread with the infinite Tenuity of odorous Effluvia, will infect the whole Air of that City. It is easy to conceive how the Steams of pestiferous Bodies may taint the Air, while they are alive and hot: but I think it appears likewise, by their being frequently opened and dissected in *Marseilles*, without any Danger to the Surgeon or Assistants; that there is no Danger from them when cold, and not putrify'd. I think, from the Facts above-mention'd,

mention'd, one may easily account for the Propagation and Continuance of the Plague in some Places infected, and the Preservation of neighbouring Places from the Infection; if there is no particular Disposition in the Air to propagate the Distemper. Any infectious Distemper is easily propagated amongst Human Creatures living close together. The Plague of *Copenhagen*, 1711, cut off the greatest Part of the common People, who are most narrowly lodged in that City.

IX. As to the Pestilential Levains convey'd in Goods, it is a popular and safe Opinion; but many Writers about the Plague, and particularly *Diemerbroeke*, seem to despise it. The Fact of its being brought into *Marseilles* by infected Goods, is positively asserted by the Town Physicians, and as positively deny'd upon a stricter Examination by those sent down by the Regent. In the last Plague of *London*, Dr. *Hodges* positively affirms that he saw a Patient in *Westminster* with Carbuncles the Winter before the Plague broke out. As to the Plague being propagated by infected Goods, there is this one Difficulty which is not easily solv'd. In a City infected with the Plague, notwithstanding all the Pains taken by arti-



artificial Purifications to extirpate the Contagion, there must be more of the pestilential Levain left in Goods, than could be brought over in a whole Fleet ; yet when the pestilential Season is over, People return to their Houses, lie in the infected Beds, and use the same Goods, safely : And indeed, if pestilential Levains were always capable of producing the Infection, I cannot see how it is possible for the Plague ever to be extinguish'd in a Place once infected. So that I think one may conclude, That the Constitution of the Air is the chief Instrument perhaps in producing, but surely in propagating and extinguishing this Distemper, and that there is no need (with *Diemberbroke*) to have Recourse to some miraculous Operation of Divine Vengeance. The most common and feeble Powers of Nature are capable of executing the Will of the Creator, even in the extraordinary Dispensations of his Providence. The Inhabitants of those Countries which have never been afflicted with the Plague, are not less Sinners than others. I think it likewise probable that the *Turkish* Contempt of the Contagion does not propagate the Disease more than the Christian Dread of it, which brings publick Disorder,  
want

want of Care both of the Sound and Infected; for in general Contagions, more perish for want of Care and Necessaries, than by the Malignity of the Disease; they being, as it were, sequestered from Mankind. In the Plague of *Marseilles* many were buried alive. In the same Plague, when good Order was re-establish'd, of above 15000 who had gentler Symptoms, and were better attended, the greatest Part recover'd. If the *Turkish* Principles were join'd with the Christian Care and Skill, no doubt the Havock made by this Disease would be small, in respect of what it is commonly in infected Cities.

X. As to the Method of Cure of this Distemper, it is foreign to my Subject; only by the Conformity of its Symptoms with other inflammatory Distempers, especially the Small-pox, the same Methods seem to be indicated in both. As to Preservatives, there seems scarce any to be depended upon, but Flight from the infected Place. As the Disease seems to produce a general Dissolution of the Blood in Hæmorrhages of all kinds (even those Inflammations upon the Skin are Extravasations of Blood ending in Mortifications) acid and styptick Medicines are indicated, both as a Cure and Preservative,

servative, it has likewise been observ'd by the Writers on this Disease, that it is apt to invade such as are subject to intermitting Fevers, which often degenerate into the Plague. There has lately been discover'd in the *Peruvian Bark* a Virtue to resist and cure Mortifications; and what cures a Symptom, may preserve from it: Therefore I would propose, in a pestilential Constitution, the *Peruvian Bark* as an Antidote or Preservative; it prevents as well as cures some sorts of Fevers; it tempers bilious Acrimony; is styptick; cures Hæmorrhages and resists Mortifications; then why not use an Antidote so promising; if not effectual, at least harmless. A Chirurgeon at *Marseilles* told a Friend of mine, that he was sure that he preserv'd himself from the Plague by taking large Doses of the Bark; and that it had its Effect after he felt himself attack'd with the first Symptoms.

XI. There have been of late two remarkable Instances of the Influence of the Air in producing an Epidemical Disease, perhaps over the greatest Part of the Surface of the Earth; the first happen'd in the Year 1728; the last in the latter end of the Year 1732, and beginning of 1733; which being the more

recent and remarkable, I shall give a short Description of it, till a more particular one can be procur'd from the collected Memoirs of the several Countries which it invaded, of which I have seen only a few.

XII. The previous Constitution of the Air was, in *England*, and in the greatest Part of *Europe*, a great Drought, which may be inferr'd from the Failure of the Springs, in the Abatement of the fresh Water in all its usual Currents and Reservoirs, which are the best Measure of the Quantity of Moisture falling from the Clouds. What is most generally taken notice of in the Accounts I have seen from *Germany*, *France*, and some other Places, was, That the Air in the beginning of Winter, especially in *November*, was more than usually filled with thick and frequent Fogs, the Matter of which was not precipitated upon the Earth in Rain, Snow, or any other Fruits of the Air. Fogs are so usual in this Country in *November*, that there was nothing particular observ'd about them that I know. But there was hardly any thing fell from the Clouds during the Month of *November*, except a very small Quantity of Snow, attended with a Frost of  
no

no long Duration; and this was all the Winter we had. In the Northern Parts of *France* there was a very small Quantity of Snow, which lasted from their 15th and our 4th of *November*, till after *Christmas*. This was succeeded by Southerly Winds and stinking Fogs, during which there was observ'd by some Chirurgeons a great Disposition in Wounds to mortify. Both before and during the Continuance of the Disease in *England*, the Air was warm, beyond the usual Temper of the Season, with great Quantities of sulphureous Vapours, producing great Storms of Wind from the South-West, and sometimes Lightning without Thunder.

XIII. As to the Time of Invasion of the Disease, they were different in different Countries. It invaded *Saxony*, and the neighbouring Countries in *Germany*, about the 15th of *November*, and lasted in its Vigour till the 29th of the same Month. It was earlier in *Holland* than in *England*; earlier in *Edinburgh* than in *London*. It was in *New-England* before it attack'd *Britain*; in *London* before it reach'd some other Places westward, as *Oxford*, *Bath*, &c. and, as far as I can collect from Accounts, it invaded the Northerly Parts

of *Europe* before the Southerly. It lasted in its Vigour in *London*, from about the middle of *January* 173<sup>2</sup>, for about 3 Weeks; the Bill of Mortality, from *Tuesday* the 23d to *Tuesday* the 30th of *January*, contained in all 1588, being higher than any time since the Plague. It began in *Paris* about the beginning of their *February*, or the 21st of our *January*, and lasted till the beginning of their *April*, or the 21st of our *March*; and I think its Duration was longest in the southerly Countries. It raged in *Naples* and the southern Parts of *Italy* in our *March*. The Disease, in travelling from Place to Place, did not observe the Direction, but went often contrary to the Course of the Winds.

XIV. The Uniformity of the Symptoms of the Disease in every Place was most remarkable. A small Rigor or Chilliness, succeeded with a Fever of a Duration (in such as recover'd) seldom above three Days. This Fever was attended with a Headach, sometimes Pains in the Back, Thirst in no great Degree, a Catarrh or thin Defluxion, occasioning Sneezing; a *Coryza*, or Running at the Nose; a Cough with Expectoration of a thin Pituite at first, and afterwards  
of

of a viscid Matter ; in which, if there was observ'd a clear oily Matter, it prov'd generally the Case to be mortal, for this clear Matter was purulent. These were the most common Symptoms : But a great many during that Season were affected with Spitting of Blood, Pleurifies, and Inflammations of the Lungs, dangerous, and often mortal ; in some Places, particularly in *France*, the Fever after six or seven Days ended in miliar Eruptions ; in *Holland* often in Imposthumations of the Throat ; in all the Blood was fizy ; and every where the Disease was particularly fatal to aged People. What was observable was, that the Fever left a Debility and Dejection of Appetite and Spirits, much more than in Proportion to its Strength or Duration ; and the Cough outlasted the Fever in some more than six Weeks or two Months.

XV. There was during the whole Season, a great Run of Hysterical, Hypochondriacal, and Nervous Distempers ; in short, all the Symptoms of Relaxation. These Symptoms were so high in some as to produce a sort of Fatuity or Madness, in which, for some Hours together, they would be seiz'd with a wandering of their Senses, mis-

taking their common Affairs; at the same time they had not any great Degree of a Fever to confine them to their Beds; but in several who were thus affected, the Urine was observ'd often to change from pale to turbid, alternately, so that there was some Fever; tho' I did not observe nor hear that the Bark was effectual, but the saline Febrifuge Draughts had generally a most surprizing good Effect. Since this Disease has been over, the Air has continued to be particularly noxious in Diseases which affect the Lungs, and for that Reason occasioning a great and unusual Mortality of the Meazles, at the Rate of 40 in a Week, from which one has reason to expect some specialities in the Diseases of the succeeding Season.

XVI. The Remedies commonly successful in this epidemical catarrhus Fever were Bleeding, Sweating, promoted by watery Diaphoreticks, Blisters, and the common pectoral Medicines; and what I observ'd before, Febrifuge Draughts of Salt, of Wormwood, Juice of Limon, &c. I have not Particulars enough to enable me to enter into the *Ætiology* of this Distemper.

XVII. It



XVII. It was Matter of Fact that there was a previous ill Constitution of the Air, noxious to animal Bodies. In *Autumn*, and long afterwards, a Madness among Dogs; the Horses were seiz'd with the Catarrh before Mankind; and a Gentleman averr'd to me, that some Birds, particularly the Sparrows, left the Place where he was during the Sickness.

XVIII. The previous great Drought, as has been observ'd before, must have been particularly hurtful to Mankind: Great Droughts exert their Effects after the Surface of the Earth is again opened by Moisture; and the Perspiration of the Ground, which was long suppress'd, is suddenly restor'd. It is probable that the Earth then emits several new Effluvia hurtful to Human Bodies; that this appear'd to be the Case by the thick and stinking Fogs which succeeded the Rain that had fall'n before.

XIX. It is likewise evident that these Effluvia were not of any particular or mineral Nature, because they were of a Substance that was common to every Part of the Surface of the Earth; and therefore one may conclude that they were watery Exhalations, or at least

such mix'd with other exhalable Substances that are common to every Spot of Ground.

XX. Lastly, It is agreeable to Experience that watery Effluvia are hurtful to the Glands of the Windpipe and the Lungs, and productive of Catarrhs.

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## C H A P. VIII.

*Of the Effects of natural Explosions of the Air upon Human Bodies.*

I. **E**XPLSIONS of the Air by Lightning and Thunder produce more sudden and terrible Effects upon Human Bodies, than any other Alterations of the Air whatsoever; therefore in a History of the Effects of Air on Human Bodies, they ought not to be omitted; tho' there is little more to be said of them than that their Effects resemble those of Gunpowder, and other artificial Explosions.

II. There may be imagin'd many natural Causes of those violent Explosions of the Air: Salts and Sulphurs (of which there are great Quantities in the Air) mix'd and kindled, will produce  
great

great Explosions: Nitre, Sulphur, and Charcoal, compose Gunpowder: Of Tartar, Nitre, and Sulphur, is compos'd the *Pulvis Fulminans*, which has a greater explosive Force than Gunpowder: Acid Spirits and Chymical Oils produce Explosions: Filings of Iron, Sulphur, and Water, heat, flame, and at last produce Explosions. Dr. *Leister* imagines Lightning to be produc'd by the *Pyrites*; for the Vapour rais'd by Lightning seems, by some Observations, to have a magnetic Quality, it having sometimes chang'd the Polarity of Ships Compasses \*. But I think they are naturally accounted for by the ingenious Mr. *Hale*, in his Appendix to his Treatise of Hæmostatics, in which he has demonstrated that sulphureous Air and clear Air ferment together; therefore that Lightning is produc'd by the Mixture of the fresh pure Air above the Clouds, with the sulphureous Vapours that rise below, which, when the Effervescence is over, cools the Air.

III. No Instrument of Art or Nature kills a Human Creature so suddenly as Lightning, they being often arrested by

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\* See Abridgment of Philosophical Transactions, Vol. II.  
p. 180.

the Stroke, in the very same Posture and Attitude in which they were struck \*. The Effects and Marks on their Bodies seem to proceed from two Causes, Burning and Percussion; their Clothes being lacerated and torn; their Bodies often pierc'd with Wounds, sometimes round, resembling those from small Shot, sometimes of larger Diameters; these Wounds are without any Hæmorrhage, they being fear'd or burnt at the same time: From their resembling Gun-Shot Wounds so much, some have imagin'd that they were made by Hail produc'd that Instant; but whoever considers the History of such Accidents will find, that the Wounds are made by some penetrating Flame.

IV. In many Thunder-Storms there have been observ'd Balls of Fire perfectly round, which produce, as they move along, all the Effects of Percussion of a solid Body, which is very strange; those Meteors or Balls of Fire falling from the Clouds, have plow'd up and pierc'd the Ground very deep like a Bomb †. Those Balls of Fire have been likewise

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\* See Abridgment of Philosophical Transactions, Vol. V. p. 150. and following.

† Ibid. Vol. V. p. 148.

observ'd upon meeting with any Obstacle, to divide themselves into lesser *Stria*; and it seems to me that those cauteriz'd Wounds are produc'd by fiery piercing Darts or Balls. The Effects of Burning appear often upon the Skin, which parch'd, shrivell'd, black, and burnt, the Flame taken in with the Breath has often shrivell'd the Lungs.

V. A second Effect has been the moving Bodies from the Place by the Blast, like that of being blown up by Gunpowder, of which there are many Instances.

VI. A third Effect is a great Stroke from the Air, returning with great Violence to restore the Balance after the Vacuity made; as upon the blowing up of a Powder-Mill, the Windows of adjacent Houses are all bent and blown outwards, by the elastick Force of the Air within the Houses exerting itself, by being deliver'd from the Counterpoise of the Air without: The Velocity of the Air rushing into an exhausted Receiver, is at the Rate of a Mile  $4\frac{1}{8}$  Seconds of Time, a Velocity of a Mile in  $\frac{1}{4}$  of a Minute, is capable of producing prodigious Effects. I have talk'd with Persons who have been near a Blast of Lightning,

ning, and have been knock'd down very near dead ; they told me they felt a great Blow, as it had been from a hard Body : Many such People, who have not been within the Action of the Flame, have recover'd from this Percussion. Bodies Thunder-struck have often Contusions upon them. There are some Thunder-struck People who have recover'd after a Fever attended with a Delirium ; therefore such as have been wounded are very hard to cure, as all Burns are. The serpentine and crooked Dartings of Lightning are not occasion'd by the Train of sulphureous Vapours, for almost the same Appearance happens upon striking a glass exhausted Receiver with the Palm of the Hand.

C H A P. IX.

*Practical Aphorisms relating to the Air, drawn from the Doctrine of this Essay, and from other Writers of Epidemical Diseases ; of which some are certain, others confirm'd by some Observations, and are set down as Subjects of further Inquiry.*

I. **A**IR is the Principle of Life, without which no Animal can subsist a Moment.

II. Good Air, as it is the chief Instrument of Health, may justly be reckon'd amongst the greatest natural Blessings. We find by the Influence of good Air whole Nations are able to support the Want of many Comforts of Life with Chearfulness and Mirth ; and the contrary is likewise true.

III. Mankind, by Reason and their locomotive Faculty, have in some measure the Power of defending themselves from the Injuries of the Air ; but few have the Choice of the Air in which they live.

IV. Custom enables human Creatures to support the Effects of Air, and renders the Alterations produc'd in their Solids

Solids and Fluids familiar and less hurtful. By N<sup>o</sup> VII. Chap. V. Animals by Custom can better support the Air-pump: Therefore,

V. Every Human Creature whose manner of Life demands, and whose Constitution can bear it, ought to inure themselves to the outward Air, in several sorts of Weather.

VI. In the Choice of Habitations for Mankind, the Wholsomness of the Air is a principal Consideration.

VII. Air is as much a Particular in the Purchase of a Seat, as the Soil.

VIII. The Endemial Diseases of temperate People are the Product of the Air; and the best Mark of the Wholsomness of the Air is the customary Longevity of the Inhabitants, or the Rate of their Bills of Mortality.

IX. The local Qualities of the Air depend upon the Exhalations of the Soil, and those of its Neighbourhood, which may be brought thither by Winds.

X. A Soil, gravelly, chalky, sandy, has but a small Quantity of Perspiration, for it imbibes Moisture, and therefore is free from noxious Exhalations.

XI. From a rich, fat, marshy Soil, a great Quantity and Variety of Vapours are rais'd by the Action of the Sun,  
and



and the Heat communicated to the Surface of the Earth ; which must at certain Times and Seasons variously affect the Inhabitants by its Contents, consisting of Water, Oils, Salts, and several other Ingredients, of which the Analysis of the Dew is the best Index ; accordingly, rich Soils on the Banks of Rivers in hot Countries, are extremely unhealthy.

XII. Mere watery Exhalations perhaps are not so unwholsom : Soils which abound with these, are such as retain Water, as Clay and level Grounds, where the Water stagnates ; and spongy Grounds on the Tops of Hills, which attract Vapours.

XIII. The Qualities of the Springs are the Mark of those of the Air, for both the Air and Water imbibe the saline and mineral Exhalations of the Ground ; therefore where the Water is sweet and good, it is probable the Air is so likewise.

XIV. Dampness of Wainscot, rotting of Furniture, tarnishing of Metals, rusting of Iron, Efflorescence of Salts upon any Bodies, Discolourations of Silks and Linen, are Marks of Salts of an unusual Nature or Quality in the Air. *See Chap. IV. N<sup>o</sup> VIII.*

XV. The

XV. The Steams of dry Ground, without any of those noxious Qualities, are naturally wholesom and refreshing upon opening with a Spade or Plow.

XVI. In choosing Situations, Regard ought to be had to the local Steams of the neighbouring Soil ; a gravelly Situation may be render'd sickly by the Air of a neighbouring Marsh, brought thither by Winds.

XVII. Epidemical Diseases, which proceed from noxious local Steams, affect Cities less than the Country ; for in Cities there is less Perspiration from the Ground, and the Air is in some measure artificial : On the contrary, in dry Frosts, when the Perspiration of the Ground is stopt, inflammatory epidemical Diseases affect the Citizens most, being more lazy and luxurious. *See Chap. VI.*

XVIII. The Air of Cities is not so friendly to the Lungs as that of the Country, for it is replete with sulphureous Steams of Fuel, and the perspirable Matter of Animals ; therefore the Consumptive and Asthmatic are better in the Country. ,

XIX. The Air of Cities is unfriendly to Infants and Children. Every Animal is adapted to the Use of fresh,  
natural,

natural, and free Air; the Tolerance of artificial Air (as that of Cities) is the Effect of Habit, which young Animals have not yet acquir'd. The great Mortality of Children under two Years, in *London*, is not intirely owing to the small Care of the Brood of the Neceffitous, and of Bastards.

XX. The first Care in building of Cities, is to make them airy and well perflated; infectious Distempers must necessarily be propagated amongst Mankind living close together.

XXI. Private Houses ought to be perflated once a Day, by opening Doors and Windows, to blow off the Animal Steams.

XXII. Houses, for the sake of Warmth fenc'd from Wind, and where the Carpenters Work is so nice as to exclude all outward Air, are not the most wholsom.

XXIII. People who pass most of their Time in Air tainted with Steams of Animals, Fire, and Candles, are often affected with nervous Distempers. Living constantly in Air that kills Vegetables, cannot be wholsom for Animals.

XXIV. Burial Places ought to be without the Precincts of great Cities.

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XXV. The

XXV. The Country Air in Spring and Summer has a considerable Influence upon Mankind by the Steams of Vegetables, which variously stimulate, and perhaps exhilarate the Spirits; and upon the same Account the Air of a planted and inclos'd Country is different from that of an open, and in some Cases less refreshing.

XXVI. In great Latitudes, where the Difference of Heat and Cold are great, the Diet and Clothing of the Inhabitants ought to vary with the Season.

XXVII. The Qualities of Winter Air, as the Weight, Density, Coldness, Dryness of Air in frosty Weather, are such as induce a Stricture of the Fibres, and the Distempers are analogous: Therefore the Diet ought to be relaxing, such is the Use of tepid, watery Liquors, and Bathing.

, XXVIII. The copious Use of spirituous Liquors is more hurtful in the Winter, and Evacuation better tolerated, not only by the greater Stricture of Fibres, but by reason of a more copious Aliment.

XXIX. Cold, in most People, increaseth the Appetite: It is remarkable in the History of such as perish'd by Cold  
in

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in Northern Countries, that they kept their Appetite to the last,

XXX. Exercise in the Winter is more easily tolerated; necessary for promoting Perspiration, as the most durable and best Defence against outward Cold, and likewise for the Digestion of a more gross and copious Aliment.

, XXXI. In Winter the Aliment, as well as the Weather, contribute to produce the Scurvy; to correct which, the Use of Vegetables, as far as they can be supply'd, is necessary in the Winter, and a Diet almost vegetable in the Spring; and the more so, because then bilious Distempers begin to rage. /

XXXII. Defences against intolerable Extremities of Heat, as Rest, Shade, Ventilation, Grottos, or Souterrains, are as necessary Preservatives of Health, as those against extreme Cold.

XXXIII. Air approaching to Animal Heat, or 90 Degrees, is dangerous, and the Effects of it more sudden than of Cold: Heat exceeding 90 Degrees coagulates the White of an Egg: Hot Weather, of long Duration, must produce great Alterations in Human Bodies.

XXXIV. The Heat of our Summer is seldom excessive or durable, and con-

*An ESSAY concerning the*

frequently not unhealthy: During the Summer in our Climate, many chronical Distempers, and the acute ones of the Spring are silent.

XXXV. The Diseases of our Summers are most commonly the Effects of sudden Alternations of Heat and Cold.

XXXVI. The most sudden and dangerous Effects of Heat are from Insolation, or Strokes of the Sun-beams.

XXXVII. The Heat of Air ought to be so manag'd, as not to produce too great Sweats, which thicken the Fluids and relax the Solids.

XXXVIII. Too great and sudden Refrigeration by Ventilation, may be dangerous.

XXXIX. Feverish Heat may be abated by cool Air. The Management of the Air in the Patient's Room is a necessary and important Piece of the Regimen in acute Distempers. The too great Heat and Driness, and other bad Qualities of the Air, have been often successfully tempered by the Steams of some Vegetables in a Patient's Room; especially of some of the soporiferous Kind, as Henbane, Cowslips, Poppies, &c.

XL. Great

XL. Great Colds succeeding great Heats, are productive of Diseases; even cold Nights, after hot Days. Many of the acute Diseases of *Europeans* in hot Countries, are occasion'd by their exposing themselves incautiously to the serene or nightly Dew.

XLI. From the Effects of different Qualities of the Air, it is easy to determine what Air is fit or unfit for what Constitutions. A moist Air relaxeth, therefore unfit for such as have weak Fibres or are phlegmatick and bloated: A dry cold Air, with the Barometer high, contracts the Fibres, therefore apt to throw such as have a strict Constitution into inflammatory Distempers: A dry hot Air is unfit for the Lean, Scraggy, and Atrabilarious, and fit for such as are of a contrary Constitution.

XLII. The best Indications for the Choice of Air are taken from the Constitution of the Patient, and the popular Diseases of the Inhabitants. The Air of *France* fit for Hypochondriacal and Stomachicks: The Air of *Holland*, where Coughs are not frequent has been found better for some sorts of Pulmonicks than that of warmer Countries: The Air of Countries which by Heat often disposeth

to Spittings of Blood, promotes too great Sweating, and consumes the muscular Flesh, can never be good for some sorts of Consumptions.

XLIII. The Scurvy of Seafaring People is not merely the Effect of Salt Provisions, but likewise of Moisture.

XLIV. Great Alterations are produc'd in Human Bodies by great Enormities of the Seasons, and by sudden Alterations of the Weather from one Extreme to another, by Change of Situation into Air of contrary Qualities, as an Inhabitant of a cold Climate going into a hot one; by such Changes the Solids and Fluids are agitated, and the Motions being uncustomary, stimulate more.

XLV. Air exceeding the natural Heat of the Body, cannot be long endured with Safety, especially if the Humours are in an inflammatory State. I have known two Instances of malignant Fevers produc'd by the hot Air of a Bagnio.

XLVI. The Diet of the Inhabitants ought to vary with the Season and Climate; perhaps in a cold moist Air a greater Indulgence in spirituous Liquors is allowable.

XLVII. In Seasons, Climates, and Countries extremely hot, Cordials of some  
sort



fort are necessary, such as Wine and Spices.

XLVIII. The Diseases proceeding from a cold and moist Air indicate Diaphoreticks.

XLIX. The Complexion of the Inhabitants being clear and vivid, is a Sign of a wholsom Air; and contrariwise.

L. The Lungs of young People in the Prime of their Age are hot and tender, and being in immediate Contact with the outward Air, may be variously affected with its Contents and Qualities: Therefore the Choice of Air is of great Importance to Pulmonicks. In those of a more advanc'd Age, The Lungs are less hot, and more coreaceous or tough.

LI. The Mark of tender Fibres, even of the Lungs, is a vivid sanguine Complexion: Transparency of the Skin is a Sign of Slendernefs and Delicacy of its Fibres.

LII. Young Pulmonicks are subject to Consumptions, and the old to Asthmas.

LIII. Air charg'd with sulphureous Steams, such as that of Cities, is noxious to Asthmaticks; not only by the Danger of Suffocation, but by the chronical Distempers induc'd by an imperfect Re-

piration ; for when the Respiration is imperfect the Sanguification is so likewise.

LIV. Experience is the best Guide in the Choice of Air, or the Freedom of the Inhabitants from the Disease of the Patient.

LV. A good Digestion depends upon Perspiration and a good Sanguification, and that upon a good Respiration ; therefore the Choice of Air is of great Importance to Stomachicks ; a cold moist Air renders both the Perspiration and Respiration imperfect.

LVI. The Earth may be consider'd as a compound Body, under Digestion by Heat, by the different Degrees of which Heat there may be rais'd Effluvia of several sorts, succeeding one another ; and epidemical Diseases may be the Product of these Effluvia : Accordingly we find the Spring and Autumn to be Seasons of epidemical Diseases : The Alterations of Heat are the greatest before and after the Equinox, for then the Declination of the Sun changeth the fastest.

LVII. Epidemical Diseases, with all the Specialities of their Character, depend upon the Constitution of the Air previous and present : A healthy Person, without any Error in the Non-natural, is  
often

often seiz'd soon after his Arrival with the epidemical Disease of that Place.

LVIII. The Methods successful in the Cure of epidemical Diseases of one Season, are often hurtful in those of another ; this Diversity proceeds from the Temperature of the Air, which is necessary not only to be observ'd, but to be recorded.

. LIX. Great Heat and Cold succeeding one another, occasion Pleurifies and Quinsseys.

LX. Vernal and autumnal Diseases, like Vegetables, come sooner or later, as the Weather favours them. *Hippocrates*, in the Diseases of the Autumn, takes notice of the nocturnal Accessions ; in that Season the Nights grow cooler and longer after hot Days.

LXI. *Cholera Morbus* is commonly confin'd to *August*, when the Bile is most exalted by great Heats, a strong Perspiration of the Day, and perhaps Abatement of it at Night ; likewise by the too copious Use of cold Fruits.

LXII. The dangerous Symptoms of different sorts of acute Distempers of the same Season, depend upon the Constitution of the Air, and by reason of that universal Cause, the Methods successful in one, seem to be indicated in the other.

LXIII. The

LXIII. The epidemical Disease, that is, the Master-Disease of the Season, imparts its Genius to the other Diseases; as malignant Small-pox, and a malignant Fever without the Small-pox. The Fever preceeding, accompanying, and succeeding the Plague was the same. Dr. Sydenham, from whom these six last Aphorisms are deduc'd, confirms this Observation by several Instances: Therefore, according to the Opinion of the same sagacious Person,

LXIV. It may be useful to Physick to give general Signatures and Names to Diseases from the Season.

LXV. There may be taken proper and useful Indications, both Preservative and Curative, from the Qualities of the Air: What produceth Relaxation and Fluxility seems to be indicated in Cold; Diaphoreticks in moist; cooling, acid, styptick Remedies, in hot and dry Air. )

LXVI. No artificial Defences, as by keeping within Doors, are effectual against a general Contagion of the Air; this was evident in the late epidemical Catarrh Fever: Yet such Defences may abate something of the Effect.

LXIX. Moisture

LXIX. Moisture that opens the Surface of the Earth, succeeding great Droughts which shut it, produceth a sickly Constitution of the Season ; such are Thaws after long Frosts, Rains after great Droughts.

LXX. Infants, by their pliant and tender Fibres, are more sensible of the Impressions of Air than Adults ; but as they must afterwards endure them, they ought to be made hardy by all safe Means ; such as have been inur'd to the Injuries of the outward Air, and accusom'd to a great Simplicity of Diet, are no more sensible of the Injuries of outward Air, than the Cattle. I know some strong Instances of this.

*What follows is deduc'd from the Epidemical History of Germany.*

LXXI. A watery Winter, succeeded by great Heats, often produceth malignant and mortal Fevers among Mankind, and Mortality amongst Cattle.

LXXII. Epidemical and mortal Diseases often succeed Earthquakes.

LXXIII. The Weather, and the epidemical Diseases of the same Climate, resemble one another ; the epidemical History of *Germany* fits *Britain*.

LXXIV. Like

LXXIV. Like Weather produceth like Diseases in every Season; a warm Winter, Diseases of the Spring; a cold and wet Summer, Catarrhs.

LXXV. Such as have had acute Distempers of one kind, are often affected with new and uniform Symptoms by the Enormities of the succeeding Season.

LXXVI. Southerly Winds of long Duration often produce Petechial or Spotted Fevers.

LXXVII. From Rains after great Frosts in the Winter, glandulous Tumors and suffocative Catarrhs; from the same Constitution in the Spring, Quinsys and Spotted-Fevers; what was remarkable in such a Season, pestilential Buboes formerly cur'd, began to run.

LXXVIII. Diseases of a very odd and peculiar Nature have sometimes succeeded an inconstant Season, as Melancholy, Madness, *Furor uterinus*, which seem'd infectious; this at *Mansfield*, 1698.

LXXIX. From an *April* extremely cold and wet, all the Diseases of the Winter, Madness, Epilepsies, Catarrhs of all kinds.

LXXX. In the Epidemical History of *Germany*, many of the Observations of *Hippocrates* are confirm'd.

LXXXI. From

LXXXI. From an unusual Inconstancy of the Weather, and perpetual Changes of the Wind from East to West, epidemical Dysenteries.

LXXXII. From Extremity of Heat in the Dog-days, a rainy Season, a malignant Spotted Fever.

LXXXIII. From Frost and Snow in *April* and *May*, an extremely mortal Small-pox and Dysentery in Autumn.

LXXXIV. From rainy Seasons, Headaches, Toothaches, Rheumatisms, Asthmas.

LXXXV. From great Enormities of the Seasons a great Run of epidemical Distempers.

LXXXVI. From frequent, great, and sudden Changes of the Weather, acute Distempers with dangerous Symptoms.

LXXXVII. In orderly Seasons the common popular Diseases neither rise nor mortal.

LXXXVIII. From hoar Frosts in the Morning, succeeded by hot Days in the Summer, an unusual Run of dangerous intermitting Fevers and Jaundices. According to that of *Hippocrates*, from Heat and Cold in the same Day, expect Autumnal Diseases.

LXXXIX. The

LXXXIX. The sickly Constitution attending Thaws is mended by Winds blowing off the Vapours.

XC. From extreme and lasting Cold, a great Run of Apoplexies and other congenerous Diseases, Catarrhs, Vertigoes.

XCI. From great Heat and Drought, burning continued Fevers, attended with Hæmorrhages, bilious Vomitings, and Dejections.

XCII. In Mildews which corrupt Vegetables, the Morning and Evening Air dangerous. Northerly and Easterly Winds, which stop the Perspiration of Vegetables (abating their Frangency) have probably the same Effect upon Mankind.

XCIII. Epidemical Diseases depend not only on the present, but the previous Constitution both of the Air and Patient: A hot Season often produceth the Scurvy and other cutaneous Irruptions; after previous Cold there have been Scurvies, which were exasperated by Heat, as that in the Memoirs of the *Academie de Sciences*.

XCIV. Weather which produceth no uneasy Sensation in Human Bodies, is wholsom as long as it lasts; but the Indolence produc'd by such Weather may make them more sensible of the Agitations,



tions, both of their Fluids and Solids by the Change.

XCV. The epidemical Diseases of Animals much expos'd to the Air, and whose Diet is simple, depend upon the Constitution of the Season. The Difference of the Quality of the Fruits of the Ground operate likewise, but not so much as the Air.

XCVI. Journals of the Weather, Reigning Diseases, and Remedies successful, would be of great Use to Mankind, and more especially to Physicians : From such Journals perhaps it might be possible to predict both the Weather and the epidemical Diseases.

XCVII. In judging of the Constitution of the Air, many things besides the Weather ought to be observ'd : The Diseases of Vegetables and Brutes ; in some Countries, the Silence of Grasshoppers ; Want of Mellification in Bees ; Desertion of Birds ; Quantities of Insects ; sulphureous Vapours ; Mortality of Diseases commonly not dangerous ; such things have been observ'd to be significant.

XCVIII. In Cities infected with the Plague, the most effectual Care of the Police is an early and quick Separation of the infected Houses, Streets, Quarters  
of

of the City from the uninfected, with proper Assistance of the Sick, and a Removal of the other Inhabitants into some airy and well perfated Incampment, in Tents or Barracks.

XCIX. By good Government many of the Infected may be sav'd, and many Sound preserved from the Infection. In the History of the Plague of *Marseilles*, one may see the bad Effects of Confusion and Neglect in the Beginning, and the good Effects of Order towards the End.

C. The *Peruvian* Bark has promising Qualities as an Antidote in a pestilential Constitution.

F I N I S.











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